Interreg CENTRAL EUROPE

Dynamic Light

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GUIDELINE ON FINDING A SUITABLE FINANCING MODEL FOR PUBLIC LIGHTING INVESTMENT

Deliverable D.T2.3.3 Best practice guide

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DYNAMIC LIGHT

Project description

The Dynamic Light project aims to demonstrate the importance of providing light under a variety of circumstances and to examine who uses lighting at what time and for how long. The project explores strategies for introducing energy-efficient lighting in urban areas and identifies the steps required to translate strategies into action, from the initial idea through the analysis, geographic information system data mining, strategy development, financial modelling, procurement process, implementation and evaluation. These strategies are intended to facilitate investment in pilot and demonstration projects that bolster acceptance of energy-efficient lighting among end-users and urban planners by improving the quality of dynamic light and adapting it to social needs. The project examines the implementation of public lighting under conditions typical of European municipalities.

Consortium

Hochschule Wismar	DE	Ernst-Moritz-Arndt-Universität Greifswald	DE
BSC, Poslovno podporni center d.o.o. Kranj	SL	SWARCO V.S.M. GmbH	DE
PORSENNA o.p.s.	CZ	Grad Čakovec	CR
Međimurska energetska agencija d.o.o.	CR	Deutsche Lichttechnische Gesellschaft e.V.	DE
Comune di Cesena	IT	Poltegor-Instytut, Instytut Górnictwa Odkrywkowego	PL
TEA SpA	IT	Hansestadt Rostock	DE
Fondazione Bruno Kessler	IT		
Spath MicroElectroni cDesign GmbH	AT		

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GUIDELINE ON FINDING A SUITABLE FINANCING MODEL FOR PUBLIC LIGHTING INVESTMENT: DELIVERABLE D.T2.3.3 – BEST PRACTICE GUIDE

Investment in energy efficiency upgrades of street lighting infrastructure offers high energy savings and carbon dioxide emission reduction. It is also very cost-effective and has a short payback period. In spite of these arguments, a large share of the infrastructure in many countries of Central Europe requires refurbishment. The budgetary constraint of its owners, who are often municipalities, is a common reason. To overcome it, creative business models are required to attract other investors and overcome the barrier of high up-front investment costs. The report provides a review of existing financing models, including self-financing, debt-financing, third party financing, and project finance. The report provides the overview of each model, identifies the projects to which it could be applied, specifies its advantages and disadvantages, and provides a case study.

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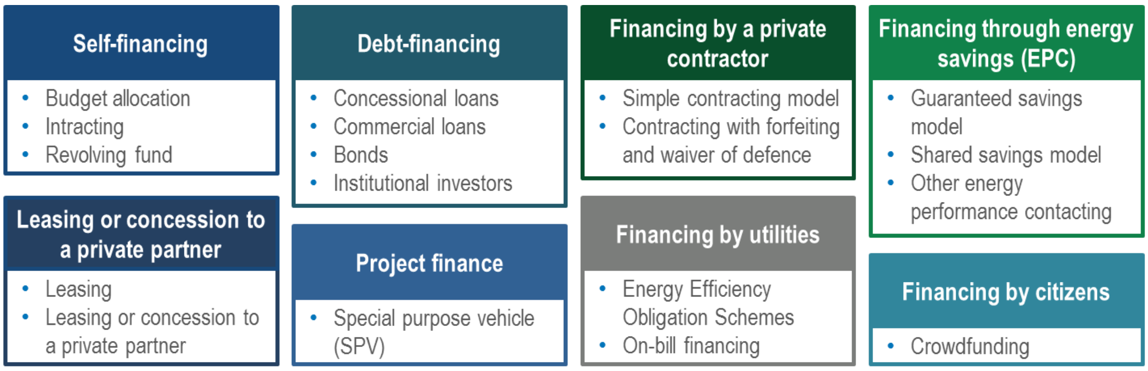
Executive summary

Even though street lighting offers high and cost-effective energy efficiency potential, its energy efficiency upgrade rate is low in many jurisdictions in Central Europe. High up-front investment costs are among the highest barriers for municipalities and municipally-owned companies to upgrade street lighting. To overcome this barrier, creative financing models are required to attract private investors.

The report offers an extensive overview and analysis of financing models used to finance the upgrade of the urban street lighting infrastructure. These include different alternatives of self-financing, debt-financing, third-party financing, and financing using public-private partnerships presented in Figure 1. The report describes the key design features of each model, specifies its advantages and disadvantages, identifies what projects it is suitable for, and, finally, provides a case study. Table 1 provides a summary of findings.

Figure 1: Financing models for public street lighting investment



Each of the models has its trade-offs as well as economic, market, and legal conditions, in which it can be applied. For example, financing street lighting upgrades off municipality's balance reduces the burden on the public budget but will require a certain project size and cash-flows as well as it may imply losing full project ownership and increase the complexity of project implementation. Therefore, the choice of appropriate model should be justified to address the specific situation of a municipality. Some of the key considerations in choosing a financing model are availability of own resources, municipality's borrowing capacity, project size and bankability, maturity of the market of energy service providers and energy services companies (ESCOs), and finally the landscape of the EU, national and sub-national policies and financial incentives.

Self-financing. The most straightforward financing model is paying for street lighting upgrades from own funds of municipalities or using grants available from the national or EU programmes. To minimize the burden on tax payers, the public sector can design and implement additional schemes which help raise the funds, for example, an internal performance contracting or a designated revolving fund.

Debt-financing. Many municipalities, whose own funding resources are limited, obtain debt which is then paid back from the tax revenue of municipalities and/or saved energy costs. Municipalities can obtain a concessional loan from available public lending programs, a commercial loan from a commercial bank, or they can issue municipal bonds.

Financing by a private contractor. The most interesting alternative for the municipal actors is, however, to reallocate the burden of financing street lighting infrastructure on third parties, e.g. contracting an energy service contractor. There is a wide variety of such contracts. In a simple contracting model, the contractor directly receives a contracting fee, which covers the costs of planning, financing and execution of the infrastructure retrofit, as well as its margin. In a more complex model with forfeiting and waiver of defence, the roles of the city and the contractor are similar to the simple contracting model, but a bank enters into agreements both with the contractor and with the city.

Financing through energy savings. The other configuration is energy performance contracting (EPC) models, which could be applied when either a municipality or the contracted party pays for energy supply. In this model, the energy cost savings achieved via a reduction of energy consumption are used to finance the street lighting retrofit. Typically, the contracted energy service company guarantees an energy saving level to be achieved. In shared savings EPC models, additional energy savings achieved on the top of the guaranteed level are shared between the municipality and the contractor.

Leasing or concession to a private partner. Leasing models are also used for financing street lighting upgrades. Leasing envisages selling ownership rights for street lighting infrastructure by municipality to a private contractor conditional to its upgrade, operation, and management. The municipality than leases it back from a private contractor for fixed fee over a period, after which the ownership rights are transferred back to the municipality. In the case of concession, a private partner is granted rights to operate and maintain street lighting and accrue all benefits resulting from the energy efficiency upgrades.

Project finance. Project finance is often used to raise private capital for large bankable projects with capital costs over ~EUR 20 million. In this model, a special purpose vehicle (SPV) is established, which carries the investment project on its balance sheet. SPV structure is an important advantage for both municipalities and private investors, because it removes the burden from the balance sheets and isolates project risks within the SVP.

Financing by utilities. Energy Efficiency Obligation Schemes (EEOSs) are operational in eleven EU Member States[1]. EEOS is a policy mechanism that requires energy providers and / or distributors covered by the scheme to meet certain energy saving targets through investments into eligible end-use energy efficiency measures. Depending on the specific country provisions street lighting is also an eligible measure. In the case of on-bill financing, utility provides a loan to a municipality for the upfront investment and the municipality repays the cost through its energy bills. On-bill financing is not common in Europe, but more spread in the United States.

Crowdfunding. Crowdfunding is relatively new financing option and most often used by young innovative companies and start-ups for small or medium-scale projects. It implies raising funds from a large number of individuals or small-scale investors via online platforms. Crowdfunding creates a community around the project, where people can be more involved and provide useful insights and ideas to the project. Many community or city projects are also increasingly using this instrument (European Commission 2016b).

[1] Denmark, UK, Ireland, France, Spain, Italy, Latvia, Poland, Bulgaria, Austria, and Slovenia.

Table 1: Summary of findings

	Model	Good for municipalities, because they	Not perfect for municipalities, because they	Projects financed with this model
Self-financing	Municipal budget	1. own and structure project 2. pay no interests on capital 3. receive fully saved energy costs	1. carry fully up-front cost 2. bear all investment risks 3. may lack capacity in structuring the deal	1. any type of infrastructure projects given the availability of the budget and expertise
	Intracting	1. can reuse capital 2. do not need external capital 3. cooperate within their units 4. pay no interests on capital	1. carry fully up-front cost 2. bear all project risks 3. may face lower project efficiency vs when the upgrade is delivered by private actors	1. any projects, including small and not interesting for private investors
	Revolving funds	1. can reuse capital 2. may design a self-sustaining and long-time oriented fund 3. may involve private investors 4. could merge their funds, if municipalities are small	1. face high transaction cost of fund set up 2. need to allocate manpower for the duration of the whole project 3. may experience tensions if private and public capital is merged	1. medium to large size municipalities 2. long-term multi-aimed orientated projects and programmes
Debt financing	Low-interest loans from public banks	1. pay low-interest rates 2. can access capital 3. can combine this model with other financing models (e.g. revolving fund)	1. pay interests on capital	1. especially accessible for public energy efficiency projects
	Commercial loans from banks	2. the same as in the previous scheme	1. obtain conventional debt based on their credit record 2. pay interest at market rates 3. do not enjoy special conditions for energy saving projects	1. financially sustainable infrastructure projects of various sizes
	Municipal bonds	1. can access capital at lower cost compared to lending from commercial banks	1. face extensive and costly preparation	1. medium to large financially sustainable projects 2. municipalities having access to a bond agency
	Institutional investors	1. enjoy low cost of capital as institutional investors are long-term orientated and risk averse	1. may face lack of experience of institutional investors as their share in EU climate investment is 1-2% 2. face high transaction costs	1. large projects competitive in terms of financial risks and return
Financing by a private contractor	Simple contracting model	1. do not carry project cost on their balance sheet 2. can select specialised companies via a tendering process	1. may face higher financing cost compared to concessional loans 2. may face restrictions on access to public support	1. medium to large projects
	Model with forfeiting and waiver of defence	1. and 2. are the same as in the previous model 3. pay lower interest rates than in the simple contracting model	1. face higher interest rates than in concessional loans 2. face high complexity 3. have to provide a guarantee for banks	1. medium to large projects
Financing by private partner through energy saving	EPC – guaranteed savings	1. obtain new infrastructure without peaks in their spending 2. outsource risks to contractors 3. pay constant bills during the contract, possibly lower than before 4. enjoy low operation costs once the contract ends	1. may face a problem to attract private partners if a project is too small 2. may face low financial performance in case energy prices are low 3. face a lack of motivation by private partner to reduce energy demand more than guaranteed in the contract	1. projects with a high energy cost savings potential 2. municipalities should have sufficient financial resources to pay the fees as set in the contract
	EPC – shared savings	1., 2., 3., and 4. are the same as in the previous model 5. receive a share of additional energy cost savings 6. enjoy additional energy savings due to incentives for them on both sides	1. and 2. are the same as in the previous model	1. and 2. are the same as in the previous model
	EPC - immediate	1. enjoy maximum energy savings as soon as possible	1. will have relatively old infrastructure by the end of the	1. projects with very old inefficient

	Model	Good for municipalities, because they	Not perfect for municipalities, because they	Projects financed with this model
	savings		contract	infrastructure
	EPC - staggered savings	1. enjoy a reasonably modern infrastructure through the contract	1. will enjoy the whole amount of energy savings at a later stage	1. projects with existing luminaries of different age and technology
	EPC - related payments	1. enjoy more accurate quantification and verification of energy	1. is the same as in the previous model	1. projects with a high potential of energy savings
Leasing and Concession	Leasing by a contractor to municipality	1. spread financial risks and costs over time 2. outsource technical risks to the private sector 3. do not increase their debt but enjoy new infrastructure	1. may run in higher costs of leasing vs self-financing in the long term 2. may have less control over the assets	1. projects with high up-front cost
	Concession to a private partner	1. outsource risks to the private sector 2. receive steady cash inflow	1. face complex setup and administration 2. need to organize a tender to choose a concessioner 3. need well oversight of the project	1. any projects with viable private actors in the municipality
Project finance	Project finance	1. isolate project risks within a special purpose vehicle 2. may foresee deductions or withhold payments or apply penalties if private partners fail to deliver the services	1. face high transaction costs related to the preparation and implementation of the special purpose vehicle	1. large projects (> EUR 20 million) 2. a consortium of several municipalities and investors / financiers
Financing by utilities	EEO schemes	may create pressure on utilities to meet targets through financial penalties 2. do not bear high upfront investment cos	1. need strong regulatory framework 2. need strong governance	1. possible in countries adopted EEOs
	On-bill financing	1. repays investment through its energy bills 2. enjoy relatively simple implementation arrangements	1. face lack of experience as the model is rare in Europe	1. small to medium sized projects
Financing by citizens	Crowd-funding	1. enjoy additional private investors	1. lack a guarantee that sufficient funding will be raised 2. face lack of investors' experience 3. may face the situation when investors wish to exit 4. face a lack of regulation 5. may face various issues with responsibilities towards multitude of small investors	1. small to medium sized projects

Note: EEO - energy efficiency obligation

Abbreviations

CO2	Carbon Dioxide
CEB	The Council of Europe Development Bank
EC	The European Commission
EBRD	The European Bank for Reconstruction and Development
ED	The Energy Fund Hague (Energiefonds Den Haag)
EEEF	The European Energy Efficiency Fund
EIB	The European Investment Bank
ELENA	European Local Energy Assistance
ENEF	The Lithuanian Energy Efficiency Fund
ENIGMA	Enlightment and Innovation ensured through Pre-commercial Procurement in Cities
ERDF	The European Regional Development Fund
EPC	Energy Performance Contracting
EPRP	Energy Performance Related Payment
ESIF	The European Structural and Investment Funds
ESCO	Energy Service Company
EU	The European Union
HEID	The Holding Fund (Holdingfonds Economische Investeringen Den Haag)
HPM	High Pressure Mercury (lamps)
FEF	The Foresight Environmental Fund
FRED	The Urban Development Fund (Fonds Ruimte en Economie Den Haag)
JESSICA	The Joint European Support for Sustainable Investment in City Areas
GHG	Greenhouse Gas Emissions
GLA	The Greater London Authority
GSHF	The Greener Social Housing Fund
INPP	International Public Partnerships
JESSICA	Joint European Support for Sustainable Investment in City Areas
LED	Light Emitting Diode
LEEF	The London Energy Efficiency Fund
LGF	The London Green Fund
LWARB	The London Waste and Recycling Board
KfW	Kreditanstalt für Wiederaufbau
NGO	Non-Governmental Organization
QECBs	Qualified Energy Conservation Bonds

SEIA	Sustainable Energy Authority of Ireland
SEAP	Sustainable Energy Action Plan
UK	The United Kingdom

Terms and definitions

Term	Definition	Source
Blending	Ability to combine financing with additional sources of investment, such as guarantees, trust funds, and project bonds.	(EIB 2017a)
Debt finance	Lending money to a company, government or project in the form of a loan or bond.	(Reyes 2012)
Equity	A stock or any other security representing an ownership interest or partial ownership of a company. The value of the investment is related to the success or otherwise of the company, rather than the interest payments accrued by debt finance.	(Reyes 2012)
Forfeiting loan	A type of financing whereby a bank advances cash to the contractor against invoices or a promissory note guaranteed by the city. The term is used primarily in international trade of capital goods.	Own definition
Grant	Transfers made in goods, cash or services from a government or other organisation to an eligible recipient for a specified purpose, with no repayment required.	(OECD 2001)
Guarantee	A written commitment to cover risks for all or part of a third party's debt, obligation or loan portfolios in order to provide potential economic and regulatory capital relief.	(European Structural and Investment Funds 2014)
Institutional investor	An institution that manages and invests other people's money. Examples: pension funds, insurance funds, investment funds, and other entities on the capital market.	(OECD 2014)
Leasing structure	Renting of an asset for an agreed period of time as an alternative to outright purchase.	(OECD 2001)
Loan	The act of giving an agreed sum of money to another party in exchange for future repayment of the principal amount, along with interest or other finance charges, within an agreed period of time.	(European Structural and Investment Funds 2014)
Microcredit	Provision of thrift, credit and other financial services and products of very small amounts to low-income individuals in rural, semi-urban and urban areas in order to raise income levels and improve living standards.	(College of Agricultural Banking n.d.)
Mezzanine financing	A hybrid of debt and equity financing that gives the lender the right to convert to an ownership or equity interest in the company in case of default. Mezzanine debt may take the form of debt, senior subordinated debt or private, 'mezzanine' securities.	(Silbernagel and Vaitkunas n.d.)
Senior debt	Debt that is repaid before other claims in the event of liquidation.	(World Bank 1991)
Subordinated debt	The opposite of senior debt; it is repaid only after payments on other obligations have been made. Also referred to as 'junior debt'.	(World Bank 1991)
Venture capital	Financing provided in the form of capital investment for a new business or for product development, often in exchange for equity.	(OECD n.d.)

1. Introduction

Investment in the upgrade of urban street lighting infrastructure offers energy savings and carbon dioxide (CO_2) emission reduction up to 80%. It is also very cost-efficient and has a short payback period. In spite of these arguments, a large share of the infrastructure in many European countries requires refurbishment. The budgetary constraint of its owners, who are often municipalities or municipality-owned companies, is a frequent reason.

Many municipalities and municipality-owned utilities retrofit the street lighting infrastructure from own resources. However, often they do not have enough capacity and/or funds for the upgrade, and therefore they either seek for the support from public sources, usually provided in a form of grants and/or rebates, or they seek for third-party financing. In the latter cases, the retrofit may require contractual agreements between several parties. To attract these parties, creative financing models are required.

The report aims to provide the evidence-base for the design of the guide on how to find a suitable financing model for public lighting investment. The report identifies, reviews, and analyses financing models used to finance the upgrade of the urban street lighting infrastructure. These include different alternatives of self-financing, debt-financing, third-party financing, and financing using public-private partnerships. Among these, the report in particular discusses the models, which minimize the burden on the public budget. The report provides an overview of each model, identifies the projects to which it could be applied, specifies its advantages and disadvantages, and provides a case study.

The report builds on one of the deliverables of the Dynamic Light project, which aims to promote dynamic, intelligent, and energy efficiency urban lighting in the countries of Central Europe. These countries include Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia, and Slovenia. The project is co-financed by the Interreg Central Europe platform.

The main target group of the paper are the organisations, which own, operate, and make decisions on the modernisation of the street lighting infrastructure in Central Europe, e.g. municipal governments, municipally owned utilities, as well as private or partially private companies delivering these functions. The second target group of the paper are the organisations, which are involved in the financing of the street lighting upgrades, such as the operators of the European Union (EU) funds, the operators of the federal support schemes, public and commercial banks, energy service companies, manufacturers of advanced lighting solutions, as well as institutional investors (pension funds, insurance funds, investment funds, and other agents on the capital market) interested in diversifying their portfolio.

2. Self-financing

The most straightforward way to finance the upgrade of the street lighting infrastructure is to pay for it from own funds. In a few developed countries of Central Europe, e.g. Germany and Austria, using municipal budget and dedicated national or federal funding sources is very common for funding municipal infrastructure projects.

There are several alternatives how to organize such financing. First, the upgrade could be done at once if it has a sufficient budget in a given year due to cash reserves. Second, a municipality unit could go for gradual street lighting updates to allow paying fragmented investment volumes from resulting energy savings, i.e. creating a revolving structure. Third, municipality's organisational units could contract each other within one municipality for gradual street lighting updates from resulting energy savings. Further, we discuss each of these alternatives in detail.

2.1. Financing from municipal budget

Model Overview:

The financing model of such upgrade project is rather simple, e.g. a municipality identifies an investment need, prepares a request for financing, obtains its approval, and issues a tender to select a contractor, e.g. an energy service company, which conducts the upgrade.

Advantages:

The first advantage for a municipality is that is has a full ownership of the project. Second, using own resources, no interest rate is charged.. Third, a municipality receives the whole amount of saved energy cost. Finally, it is fully up to a municipality how and how fast to implement an upgrade.

Disadvantages:

First, a municipality has to use own budget for the full up-front cost of this long-term infrastructure investment whereas the budget resources are often limited. Second, a municipality bears all risks, including the risk of non-delivery of energy savings, technical risks, risks of not well thought through decisions, and others. The project-related decisions made by a municipality could also be not fully transparent enough for the public. Finally, municipalities may often lack expertise and capacity on project implementation and best available technology solutions compared to private service providers.

Projects that can be financed with this model:

The model can be applied in any jurisdictions and to any type of infrastructure projects. However, while the model is characterized by obvious advantages and there are many successful examples of projects implemented, often municipalities search for alternatives. The critical factors are budget constraints of municipalities as well as their limited human resources and expertise. Due to these reasons, municipalities search for solutions to avoid paying the full amount of up-front costs and to reduce technical and financial risks.

Jurisdictions that applied the model:

This is the most common model of street lighting upgrade used throughout the countries of Central Europe. Below, we provide a case study of how the city of Heidelberg used the model.

Case study: the city of Heidelberg, Germany

Context:

Heidelberg is a small to medium size city in South-West Germany. In 2012, the city was inhabited by 138,000 people and by the end of 2017, it has grown up to 150,000 inhabitants. In order to accommodate the population growth, in 2008 the city of Heidelberg started converting the old train track area into a modern green district with a capacity of 12,000 persons, referred to Bahnstadt Heidelberg. The project integrated energy efficient and smart street lighting concepts as one of their central elements.[2] The concept had to comply with the standard DIN 13201 on quality features for road lighting, but not to any specific energy efficiency requirements.[3]

Project timeframe: 2008-2025.

Key stakeholders:

The model did not involve any external stakeholders such as external capital providers, energy service companies or others. The city of Heidelberg and the public utility of Heidelberg (Stadtwerke Heidelberg Umwelt GmbH) provided fully the whole amount of up-front investment. The owner and investor for the procurement and installation of poles, luminaries at the telemanagement system is the Stadtwerke Heidelberg Umwelt GmbH, and the contractor for the installation is the Stadtwerke Heidelberg Netze GmbH.

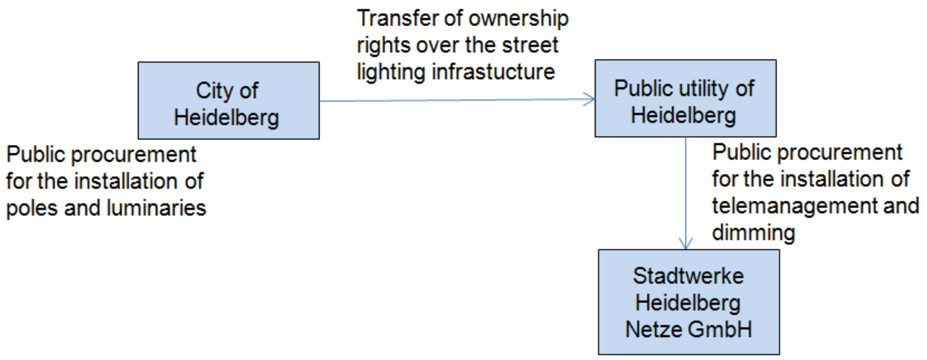


Figure 2: Operation and financing of smart lighting in Bahnstadt Heidelberg

Financing structure:

The City of Heidelberg financed the initial cost of street lighting infrastructure, including the design, purchase, and installation of poles and luminaries. After the installation of poles and luminaries, the city of Heidelberg transferred the ownership, maintenance, and operation rights to its public utility. The utility financed additional energy efficiency measures such as a telemanagement system and light dimming. The utility enjoys all financial benefits associated the project realization, e.g. avoided costs of infrastructure maintenance and operation as compared to the reference technology.

Project scope:

Heidelberg-Bahnstadt's expansion is going in parallel with the district development. At the end, probably in 2025, more than 1000 luminaires will be installed over a distance of more than ten kilometres[4].

[2] HEIDELBERG BAHNSTADT: FACTSHEET, pdf

[3] Private communication. August 11, 2017. Email: Rainer Herb, Stadtwerke Heidelberg Netze GmbH

[4] https://www.swhd.de/de/Imageprojekte/Bahnstadt/Licht/Licht.html

Project implementation and outcomes:

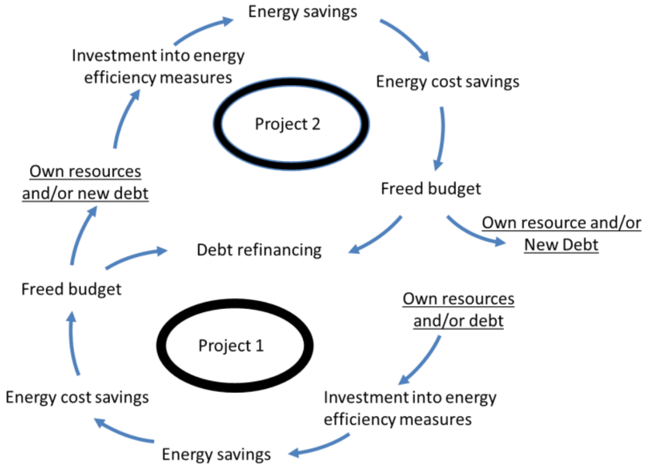
The street lighting concept relies on using light emitting diode (LED) luminaries, telemanagement of street lighting demand, and dimming adjusted to it. At night, the light output is on the bike path up to 100% when pedestrians or bikes pass by and it is dimmed to 30% when the street is not used. In all streets, the lighting is dimmed depending on traffic in several stages. Overall, the concept allows for 75% electricity savings as compared to conventional alternatives. In 2013, the concept was awarded with the Auroralia worldwide award. In 2016, the utility of Heidelberg received the German Green Public Procurement Award.[5]

Total investment costs of the project were EUR 3.5 million for the public utility of Heidelberg. The avoided electricity costs are nearly EUR 120,000 for the estimated life expectancy of 30 years. Maintenance costs can also be kept at rather low level, amounting to EUR 225/year per high intensity discharge lamp (HIT) and EUR 105/year for LED-lamp respectively.

2.2. Financing using revolving funds

To minimize the burden on tax payers, the public sector can establish a revolving fund to multiply available capital. Figure 3 illustrates a revolving fund organized for energy efficiency projects. Capital, e.g. equity or debt, is invested into a project, e.g. street lighting upgrade. The project results in electricity savings, which translate into saved electricity costs, that free some budget previously used to cover utility bills. This allows repaying the initial investment and/or reinvesting into new projects, thus creating a revolving model.

Figure 3: Capital flow in a revolving fund.



Source: Authors' own figure.

There are several options how and on what level to establish revolving funds. Fist, revolving funds can be established under municipal governments, regional or national governments. Typically, revolving models are organized at national level, however, there are also successful examples of design and implementation of revolving funds at municipal level.

[5] https://www.swhd.de/de/Imageprojekte/Bahnstadt/Licht/Licht.html

Second, a revolving fund can be fully financed with internal municipal budget allocation (internal fund) or blend public resources with external funds from donors, financial institutions and private investors (external fund). Finally, in project implementation, municipalities can fully rely on their public bodies and departments or outsource service providers, e.g. ESCOs. This section presents the following most commonly used options:

a) Establishing an internal revolving fund and performing all project works without external service providers – so called intracting or internal performance contracting;

b) Establishing internal revolving fund and outsourcing service provides / energy service companies (ESCOs) to implement projects;

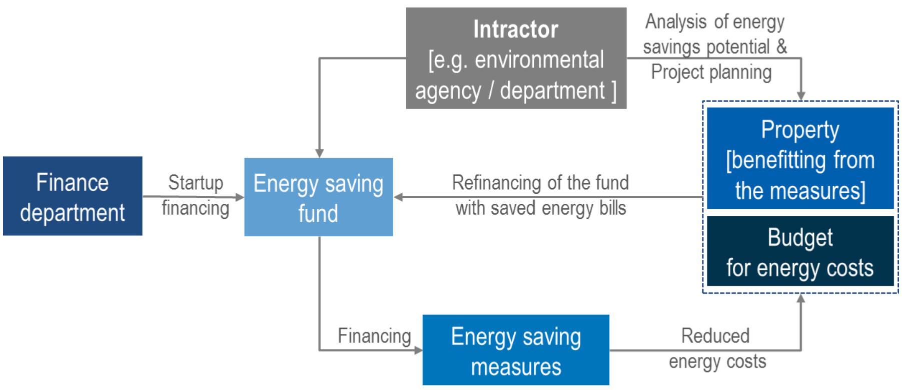
c) Establishing external revolving fund with multiple financiers and service providers.

2.2.1. Intracting (internal performance contracting)

Model overview:

Intracting is a model of public internal energy performance contracting within the municipality's organisational units without external financiers. Energy saving measures are financed through energy bill savings. The main actors in the intracting model are presented in Figure 4.

Figure 4: Illustration of an Intracting model.



Source: German Watch 2015.

The initial financing is provided from the municipal budget, for example, through establishing a dedicated revolving fund or trust. In this way, intracting is one of the variations of the internal revolving fund model. The fund or trust will finance energy efficiency or other emission reduction measures at zero interest rate and without any extra charges. Creating such a fund or trust requires political support and commitment from the department(s) responsible for the budget as well as compatible legal basis (EnergyCities 2016; Irrek et al. 2005).

Another administrative unit, e.g. environmental agency, street lighting department or municipally owned company, will serve as the “intractor”, fulfilling the role of ESCO. Namely, it will assess the energy savings potentials, calculate the investment costs and payback period, and plan the project. Here it is important that the “intractor” department has the right skills and expertise to be able to prepare and implement successfully such projects. Once the project is implemented, the achieved energy cost savings are paid back to the fund or trust until the investment has been paid off. The paid back resources are then used again for financing new energy saving projects (German Watch 2015; EnergyCities 2016).

Projects that can be financed with this model:

Municipal infrastructure projects such as building energy efficiency improvements, street lighting, combined heat and power plants, renewable energy can be financed with this model. The maximum project size will depend on the size of overall funding available from the finance department (Zirkwitz 2016; German Watch 2015). So far, most of the projects implemented under this model were energy saving measures in public buildings.

Advantages:

Intracting enables financing of energy efficiency measures with achieved energy savings by the municipalities without involvement of external financiers. In this way, cooperation between municipality's units helps to overcome the obstacle of separated municipal investment and operational budgets. Projects that are too small or not interesting for private investors can also be covered with this model. Intracting also implies no interest rate on the investment capital, reduced transaction and administration costs (EnergyCities 2016).

Disadvantages:

This model has the limitations that come with self-financing. Namely, municipality has to provide the upfront capital. Municipalities use different approaches how to sustain the fund and increase the funding available. Also the projects will be carried on the municipality's balance sheet and it will bear all related investment risks. Finally, projects financed by the municipalities only may have less efficient structure as compared to those where private investors are involved (German Watch 2015; Seifried 2011).

Jurisdictions that applied the model:

Intracting was conceptualised and adapted in Germany. Stuttgart, Lörrach, Kiel, Frankfurt, Bonn, the Federal State of Baden-Württemberg, and in Ireland have internal performance contracting schemes. Other European cities, i.e. Agueda and Almada in Portugal, Udine in Italy and Koprivnica in Croatia have also recently started intracting in their jurisdictions (German Watch 2015; EnergyCities 2017). The model has also been earlier tested for lighting upgrades in public buildings in Salzburg, Austria, University of Bordeaux, France, Niguarda Hospital, Italy, Province of Bologna, Italy, Jordanów, Poland and Malmö, Sweden (Irrek et al. 2005).

Case study: Udine, Italy

Context:

Udine is a small to medium size city in Italy with ca. 100,000 inhabitants. In 2015, its total energy cost was EUR 4.3 million. The city is active in promoting sustainable development, deployment of renewable and energy saving technologies. The main policy document is the Sustainable Energy Action Plan (SEAP). The plan sets a goal to reduce CO_2 emissions in Udine by 21% by 2020 (Infinite Solutions 2017; EnergyCities 2017).

In 2015, the city set up a revolving "Climate fund" which later became the financial instrument of the SEAP and was renamed into SEAP fund. The SEAP fund does not focus on street lighting only; it provides funding for the measures covered by the SEAP which fulfil certain criteria. The fund had initial size of EUR 32,000 and will be refinanced through savings of the city's energy bills and maintenance costs steaming from implemented energy saving measures as well as other sources (EnergyCities 2017).

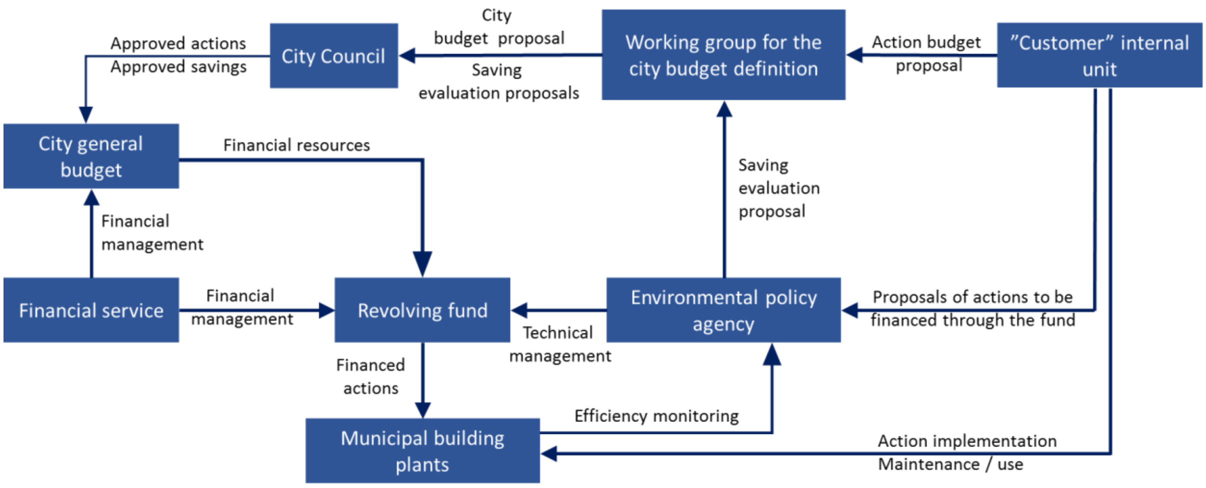
Project timeframe: 2015 – ongoing.

Key stakeholders:

This model does not include external stakeholders, such as ESCOs or third party financiers. Only city's units and departments are involved. Staff assigned to the fund consists of two technical experts, one financial expert, and the head of technical department. Figure 5 presents the key elements of the Udine SEAP fund.

The Municipal Agency for Environmental Policies provides technical expertise and management, and plays the role normally taken by ESCO. Other internal units and departments can submit their proposed energy efficiency measures to be financed by the SEAP fund. The Municipal Agency for Environmental Policies approves measures and calculates achieved energy and cost savings. The latter are directed to refinance the fund (Energy Cities 2017).

Figure 5: Operation and financing of Udine SEAP fund.



Source: (Energy Cities 2017).

Financing structure:

The initial size of the SEAP fund was EUR 32,000. It was provided from the city budget. To increase the amount of funding available, the city decided to redirect cost savings generated by four pilot energy efficiency projects implemented in 2015. The projects were not financed by the SEAP fund but will feed in saved energy bills into the fund to finance future energy efficiency measures (Infinite Solutions 2017).

Finding financial resources to set up the fund was the biggest challenge. The city plans to increase the amount of funding. It will come from the savings steaming from lower energy and maintenance costs of implemented projects, income from the Energy Efficiency Credits investment on the energy market, and city budget allocations for SEAP implementation (Energy Cities 2017).

Project scope:

Project proposals submitted to the fund by the city's units and departments are assessed against defined investment criteria and availability of funding. All measures have to be in line with the SEAP. Retrofit measures have to achieve CO_2 emission reductions and energy savings of at least 10%. There are also requirements related to the lifetime of intervention and return on investment. Proposed measures are then assessed and ranked according to these requirements (Energy Cities 2017).

The first three projects that were financed by the fund were lighting upgrades in a number of public buildings, namely the City Hall, a primary school and a parking site. Total investment cost of the projects is EUR 29,533. Cost savings from these projects will be returned into the fund to finance new energy efficiency measures in the public sector (Infinite Solutions 2017).

Project implementation and outcomes:

The fund was started only recently and only few projects have been financed until now but the city has a strong commitment to increase the amount of funding available for implementation of the SEAP. The process of setting up the fund facilitated the local staff to develop new skills and expertise. Monitoring and evaluation of the fund activity will also provide additional and detailed data on energy consumption in public buildings and assets.

2.2.2. Establishing an internal revolving fund and outsourcing service provides

Model overview:

In this option, a municipality or municipal bodies provide initial capital and manage the fund. The revolving nature of the fund is as described in the introduction to this section. The revolving fund provides finance (grants, loans or other financial instruments) to external service providers and energy service companies to implement energy efficiency projects. The returned capital and saved energy cost are re-invested into new energy saving projects. If municipalities are small and do not have enough resources to organize an individual own fund, they could merge their resources to create a common revolving fund and share its management and operation cost.

Projects that can be financed with this model:

The model could be well applied in a medium to large city or a group of smaller municipalities which need to finance long-term and multi-aimed projects. These could be building energy efficiency improvements, street lighting, combined heat and power plants, renewable energy, and similar. The maximum project size will depend on the size of overall budget available from the fund. However, cumulative energy savings should be high enough to justify the complexity of setting up the fund and its operation costs.

Advantages:

The key advantage of the model is that it could be sustainable and long-term orientated. Once a revolving fund is established and the energy savings are accrued from the first tranche of investments, the associated saved energy costs could be used for new projects. In the best case, the fund operational costs of a fund could fully be covered through interest rates, fees, service charges, and/or energy cost savings (ESMAP 2014; Limaye et al. 2014). Internal revolving model may offer an alternative financial arrangement for municipalities with limited borrowing capacity (European Commission 2017b).

Disadvantages:

Establishing a revolving fund requires political commitment, institutional and human capacity and takes time. Cash inflows will occur after several years only, so recovering fund operating costs could be not so quick (Limaye et al. 2014). Therefore, financial sustainability in terms of cost-effectiveness of the fund and the long-term strategy on resource mobilisation is important. Furthermore, a revolving fund requires an entity that acts as a fund manager to ensure good governance and management. Therefore, dedicated and experienced staff is needed to support and operate the fund that is sometimes difficult to find especially in small municipalities (ESMAP 2014).

Jurisdictions that applied the model:

An example of internal municipal revolving funds is an energy saving fund of the city of Litomerice presented below.

Case study: Litomerice, Czech Republic

Context:

Litomerice is a town in the Northern Bohemia region of Czechia having ca. 24,000 inhabitants as of 2017. The town heavily relies on the use of coal for its energy use that causes high air pollution. Due to this reason, since 2000 the town introduced a plan for energy savings and renewable energy. As a part of the plan, the town of Litomerice set up a revolving municipal energy saving fund (ESF) in 2014 in order to use limited financial resources in an effective manner (City of Litomerice 2017).

Project timeframe: 2014 – present.

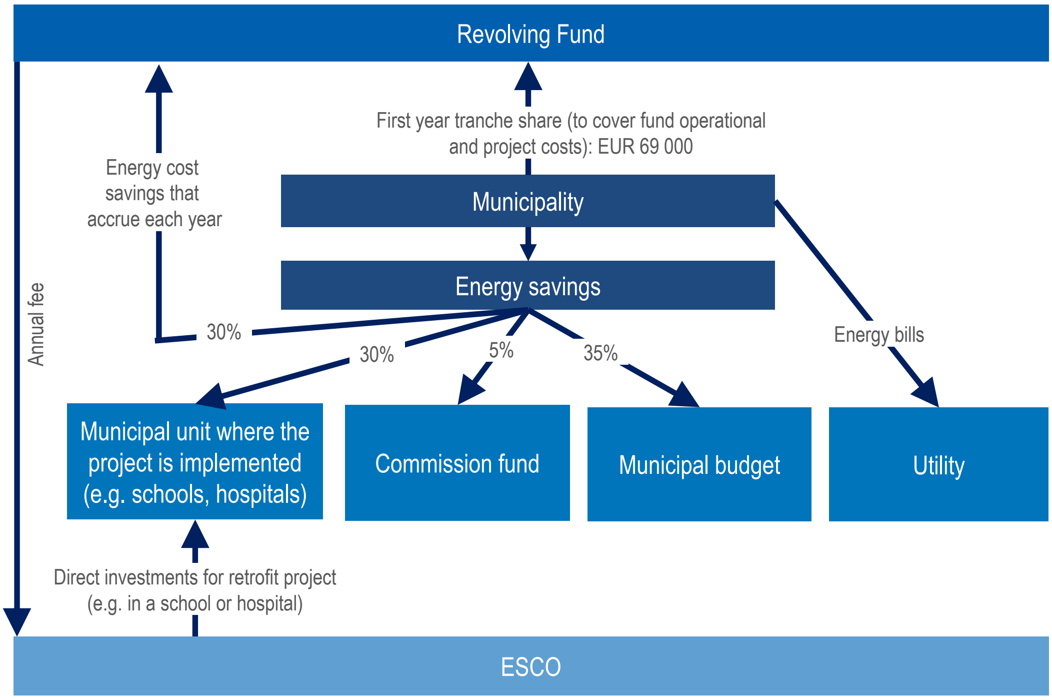
Key stakeholders:

ESF is organized as an internal revolving fund, e.g. the town of Litomerice provided the initial capital and it manages the fund itself. The European Union's Horizon 2020 research and innovation programme provided funds to conduct background research and develop the concept.

The municipal units involved are the fund manager, the municipal council, and the financial committee of the town (City of Litomerice 2017). The fund manager is the town energy manager who initiated the idea of establishing the fund, and developed the methodology. The municipal council examined the concept of the fund establishment and approved it. The financial committee assists the fund manager with the allocation of capital generated from energy cost savings.

To implement energy efficiency projects in municipal units, e.g. schools, hospitals, and others, ESF contracts ESCOs based on energy performance contracting model with guaranteed savings (see section 5.1 for details). Figure 6**Chyba! Nenalezen zdroj odkazů.** presents the stakeholders of the case study and the financial flows.

Figure 6: The internal revolving energy efficiency fund in Litomerice



Source: Authors' own figure. The data is from City of Litomerice (2017).

Financing structure:

In the starting year 2014, the municipal budget invested EUR 69,000 into ESF to cover its operation costs and the first project tranche. ESF contracts ESCOs to implement energy efficiency measures against annual fee paid over the contract period by ESF and municipal units where energy efficiency projects take place. In order to invest into these measures, ESCOs may use their own resources or obtain them from third-party financiers, e.g. public or commercial banks. ESCOs guarantee a particular amount of energy savings to be achieved.

Every year, the city monitors real energy savings, of which it deducts the annualised costs of the measures so to calculate the net energy cost savings. The net energy cost savings are distributed as follow: 35% to the municipal budget, 30% to the ESF revolving fund, 30% to municipal units where energy efficiency projects took place, and 5% allocation to the Commission Fund. The latter Fund is an incentive mechanism, which offers extra payments to the public employees, who were involved in energy saving projects in that year (City of Litomerice 2017).

Project scope:

The fund targets only energy efficiency improvements of public institutions. It supports such activities as energy audits, preparation and analysis of measures, procurement and realization of the measures. The measures supported include building retrofits, street lighting, installation of photovoltaics, purchase of electricity and gas on the stock market, and others.

Project implementation and outcomes:

Since the inception of the revolving fund and until 2017, approximately EUR 300,000 in terms of saved energy costs have been reached (City of Litomerice 2017). The city expects to reduce its energy consumption by 20% by 2030 compared to 2013 due to the fund (City of Litomerice 2017).

2.2.3. Establishing an external revolving fund with multiple financiers and service providers

Model overview: Alternatively, a revolving fund could use external funding sources and lend finance to municipalities for energy efficiency projects. The money to operate the fund, make the first tranche of investment, and further tranches could originate and/or be blended from different sources (European Commission 2017). These sources include grants and/or loans from other public and private sources such as the regional government, the national government, financial institutions, utilities, energy service companies, and/or other capital providers. Such fund could become self-sustaining over time relending capital to new projects, once it is repaid, and financing its operation costs from interests on capital lent and service charges (Limaye et al. 2014). The external fund is often managed by a dedicated fund manager, who could be a specially created new entity, a utility, an ESCO, or another organization (ESMAP 2014).

Figure 7 illustrates an example of an external revolving fund, lending funds to municipalities. The municipalities tender a street lighting upgrade to contractors and repay their loans from saved energy costs. The contracts may be conditional to project performance.

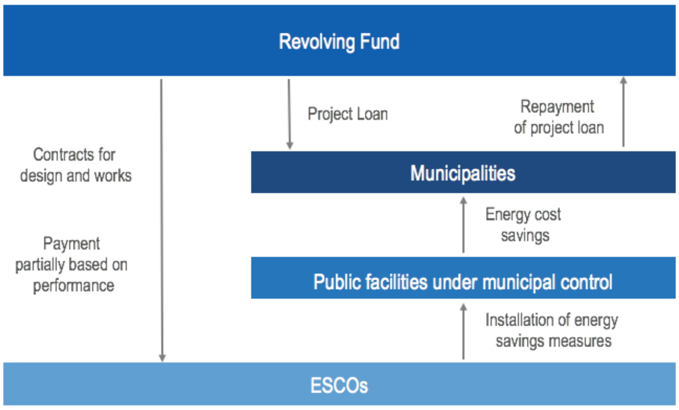
Projects that can be financed with this model:

Similar to internal energy efficiency fund, the scale and type of projects depend on the available funding and programmatic priorities of the fund.

Advantages:

Obvious advantage of external revolving funds is possibility to have a larger amount of funding through combination different funding sources, in particular financial institutions and private investors. By doing this, they allow private investors to participate in urban development projects and showcases of energy efficiency benefits to citizens and communities (ESMAP 2014).

Figure 7: Illustration of an external revolving energy efficiency fund.



Source: ESMAP 2014.

Disadvantages:

The initial set-up of a revolving fund, particularly an external one, requires the cooperation of various stakeholders and involves several steps, which increases the complexity of the financing model. Having a private entity acts as a fund manager of a partially public fund might impose a political challenge, especially when such fund has the potential to act monopolistically (ESMAP 2014). If a revolving fund uses private and public capital, tensions may arise due to a transfer of most responsibilities from donors to fund managers (e.g. project selection) (Oxfam 2017).

Jurisdictions that applied the model:

Example of external revolving funds at national level are the Croatian Energy Efficiency Fund and the Bulgarian Energy Efficiency Fund discussed in the next two paragraphs. Both finance street lighting projects. The example of external municipal revolving fund at a municipal level is Energy Fund Hague discussed in the case study below, though no street lighting projects were financed by it.

The Croatian Energy Efficiency Fund provides grants or loans to municipalities at low interest rates for street lighting projects, including those with ESCO participation. As of 2017, the fund co-financed more than 300 public street lighting projects, whose total value is more than ca. EUR 35 million, of which the fund provided more than EUR 15 million (EPEEF n.d.). The funding for energy efficiency projects is generated from regional and municipal budgets, international bilateral and multilateral cooperation programmes, projects and similar activities in the field of environmental protection and energy efficiency, revenues and inflows from managing free financial assets of the fund, donations and assistance, and other sources. The operational costs of the fund are financed from the revenues obtained from charges on polluters of the environment, charges on users of the environment, charges on burdening the environment with waste, and special environmental charges for motor vehicles.

The Bulgarian Energy Efficiency Fund provides technical assistance to municipalities in developing street lighting projects, assists their financing, co-financing or provides guarantees to other financing institutions. As of September 2017, it financed and co-financed ca. 200 various energy efficiency and renewable energy projects summing up to EUR 40 million and provided credit guarantees to more than 30 projects summing up to EUR 12 million (Energy Efficiency And Renewable Sources Fund 2017). The initial fund funding comes from Global Environment Facility (GEF), the Government of Austria, the Bulgarian Government and private Bulgarian donors.

Case study: The Hague, Netherlands

Context:

The Hague is a city in the Netherlands with slightly over 500,000 inhabitants. In 2013, the Hague has introduced a revolving fund, the Energy Fund Hague (ED) to support projects related to urban development and renewable energy infrastructure to overcome high initial costs of these projects (CityInvest 2015). The fund is organized as a limited partnership under the Dutch law (C.V. or Commanditaire Vennootschap) incorporated by the municipality.

Project timeframe: 2013 – ongoing.

Key stakeholders:

Figure 8 presents the key stakeholders of the Energy Fund Hague (ED). As the figure illustrates, ED is one of two subordinated funds of the Holding Fund 'Holdingfonds Economische Investeringen Den Haag" (HEID) (SVn n.d.). HEID was established two years earlier than ED to promote integrated sustainable urban development. HEID defines the investment strategy of its subordinate funds and functions as a financing intermediary for financial transfer to them. It also acts as controller and coordinator on behalf of Programme Authority The Hague.

HEID created two subordinated funds based on the financial mechanisms offered by the Joint European Support for Sustainable Investment in City Areas (JESSICA). JESSICA assists EU countries on how to invest financial support provided to them from European structural and investment funds (ESIF) in revolving funds in order to provide sustainable facilities accelerating investment in urban areas (European Commission 2014).

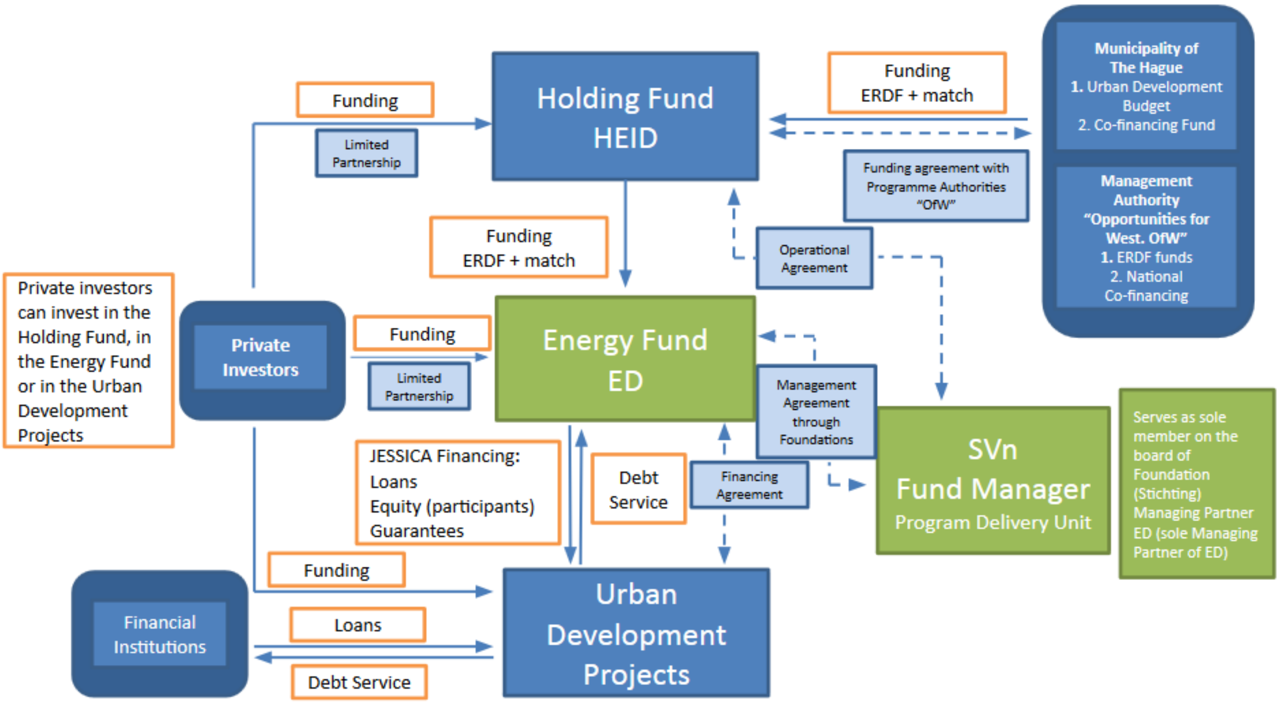
One of two HEID subordinated funds, ED aims to provide financing support to urban development projects related to renewable energy and energy efficiency. The initial funding to cover the operation costs and first tranches was provided from the Operational Programme "Opportunities for West" for West Netherlands of the European Development Fund (ERDF) co-financed from national sources as well as the city urban development budget co-financed by the city's co-financing fund. ED also works on attractive private, profit-oriented investors blending these money with public resources.

The fund manager is Stichting Stimuleringsfonds Volkshuisvesting Nedelandse gemeenten (SVn), a non-governmental organization (NGO) that manages funds on behalf of the Dutch government. As of 2017, SVn has managed the funds of 350 Dutch municipalities.

Potential fund beneficiaries[6] have to apply for funding from ED fulfilling to a range of criteria. First, they have to meet the eligibility criteria of the "Opportunities for West". Second, the projects have to contribute to the investment strategy as defined by HEID. Furthermore, the projects need to have a sound business plan and try to secure maximum finance of external market finance. More details on the fund stakeholders is provided in City Invest (2015).

[6] For example, football club in The Hague installed solar power on stadium's roof.

Figure 8: Key stakeholders of the Energy Fund Hague



Source: (CityInvest, n.d.)

Financing structure:

For the initial funding, the Holding Fund HEID obtained EUR 3.7 million from ERDF Operational Programme "Opportunities for West" co-financed by the national budget by additional EUR 0.3 million and EUR 2.9 million from the The Hague's Urban Development budget complemented by additional EUR 2.0 million from the Hague's Co-financing Fund (Luigjes 2017).

Under its investment strategy, HEID disbursed the funds further to its subordinated funds, including ED. ED's initial funding from HEID of EUR 4.0 million consisted from ERDF funds of EUR 1.7 million co-financed by EUR 0.3 million from the national public budget and the funds of the municipality of The Hague's Urban Development budget of EUR 1.0 million complemented with the EUR 1.0 million from the municipality of The Hague's Co-financing Fund. The fund aims for at least 50% contribution to the fund from private investments (CityInvest 2015) and during 2013 – 2015 over EUR 1.0 million came as private money.

In 2017, the ED's funding from public sources grew to EUR 10.9 million (Luidjes 2017; Kansenvoorwest n.d.) whereas the co-investments from the private sector amounted to EUR 51.5 million (Luidjes 2017).

Following the chosen investment strategy, SVn allocates the finance to various projects through due diligence, loan pricing, guarantees conditions, and equity arrangements. It further monitors the fund activities and reports on the fund. SVn receives a service fee capped at 2.9% from the capital contributed to the fund. Repayments to the fund and interest fees are fully reinvested in new projects (City Invest 2015).

Project scope:

The funding is targeted to private and public urban development projects in the city of The Hague, including the improvement or expansion of urban heating and/or cooling networks based on renewable energy sources such as geothermal, biomass or seawater, as well as energy efficiency improvement in office buildings and private housing. The funding is provided to businesses and NGOs that are not able to access a loan under market conditions but have financially viable projects and business models. Furthermore, potential projects need to provide social value to the municipality (SVn n.d.). The size of projects financed can vary greatly, nevertheless the share of funding is decreasing towards large-scale projects (CityInvest 2015).

Project implementation and outcomes:

By 2017, ED has funded a range of urban infrastructure projects in the private and public sector. The typical projects have been on renewables energy installations and energy efficiency measures in the commercial sector (SVn n.d.). For example, The Hague's sport center De Uithof installed LED lights and electric heat pumps; the center plans to also install solar panels to become climate neutral (SVn n.d.). As of 2017, ED has contributed to the abatement of ca. 93 tons of CO_2-eq. and created 18 new jobs in the fund (Luidjes 2017). Due to the success of the fund, it is expected to receive additional EUR 10 million of public funding, partly from ERDF. This would allow for a total volume of EUR 21 million from public funds in the ED (Luidjes 2017).

3. Debt-financing

Many municipalities, whose own funding resources are limited, obtain debt which will be paid back from the municipal budget, e.g. tax revenue of municipalities and/or saved energy costs. The financing model of such projects would include obtaining the debt, e.g. taking the loan or issuing bonds, and issuing a tender to select a contractor, who conducts the upgrade.

3.1. Debt-based financing: concessional or commercial loans from banks

Model Overview:

Most commonly, municipalities obtain low-interest (soft) or concessional loans. Low-interest rate lending programs offered by a national development bank, dedicated funds, or by the European banks and funds such as the European Investment Bank (EIB), European Bank for Reconstruction and Development (EBRD) or the European Energy Efficiency Fund (EEEF), in cooperation with local commercial banks, are widely used for energy efficiency investments by municipalities in Central Europe.

In many countries, where the public lending programs have limited budgets or do not exist, municipalities obtain a commercial loan at a market rate from commercial banks. In such case, the interest rate under which the loan is awarded does not depend on saved energy costs but on the credit record of the borrower.

Advantages:

Concessional or soft loans allow municipalities to access capital at below-market interest rates, and do not require proving a flawless credit record as in commercial loans. Furthermore, this debt capital can be combined with other financing models, such as a revolving fund, and requires low administration work.

Disadvantages:

Although interest rates are typically low, the municipality still needs to repay the debt. Furthermore, since the investment is on-balance debt for a municipality, it will downgrade its equity-to-assets ratio and thus reduce its chance to obtain other debt.

Projects that can be financed with this model:

Any municipal project could be financed using this model conditional to a municipality having a positive credit record.

Jurisdictions that applied the model:

In Germany, a dedicated programme of the KfW bank for municipalities, supported by the Government of Germany, offers loans for sustainable urban infrastructure and public buildings investments at interest rates close to 0%. It is the main source of funding available for municipalities in Germany. In Croatia and Lithuania, the revolving funds are set up from the federal budget, which provide loans and guarantees to municipal governments for energy efficiency investments. As loans and guarantees are returned, the funds are re-invested again in new projects (see section 2.2.3 for details).

Multiple loan programmes and other financial instruments are available from the European institutions and intermediaries such as EIB or EBRD. EU Member states are also encouraged to transform grant resources from the European Structural and Investment Funds (ESIF) into other financial tools, e.g. loans, guarantees, equity or risk-bearing instruments to improve the efficiency of EU resources.

Case study: Guaranteed loans from the Lithuanian Energy Efficiency Fund

Context:

The Lithuanian Energy Efficiency Fund (ENEF) was established in 2015 by the Ministry of Finance, the Ministry of Energy and Public Investment Development Agency of Lithuania. ENEF channels the finance provided by European Structural and Investment Funds (ESIF) for the support of renovation of central government buildings and modernization of street lighting. In particular for street lighting, it provides guarantees for loans granted by commercial banks and decreasing the cost of financing for municipalities.

Project timeframe: 2015 – at least until 2030.

Key stakeholders:

ENEF is managed by the Public Investment Development Agency (VIPA) that is 100% owned by the Ministry of Finance. VIPA manages the application process for guarantees as well as collects the fee and pays the compensations. The Ministry is a shareholder, supervisory board and management board of ENEF (Vaskelienė 2015).

Municipalities and municipal companies, who would like to apply for a loan at a commercial bank or contract an ESCO, may apply for an ENEF guarantee. In case an applicant cannot pay back the loan and/or loan interests to the bank in the first case or contracting fees to the ESCO in the second case, ENEF takes over these obligations and compensate commercial banks their losses. Figure 9 illustrates the financial flows of the case study.

Financing structure:

The fund manages EUR 79.5 million, of which up to EUR 14.5 million is embarked for the street lighting financial instrument. For the latter, ENEF offers 80% guarantee of eligible costs for a timeframe of up to 20 years. Whereas the guarantee fee payable by the applicant to ENEF typically depends on the applicant creditworthiness, the guarantee fee is waived for municipalities and municipal companies (Balčiūtė J. pers. com.).

Having the public guarantee allows commercial banks and ESCOs award more favourable loan and contract conditions to municipalities. In order to apply for the guarantee, the applicants have to attach such documentation as an energy audit or inventory and an investment plan. In case municipalities contract an ESCO, the model should comply with the public-private partnerships defined by the Law.

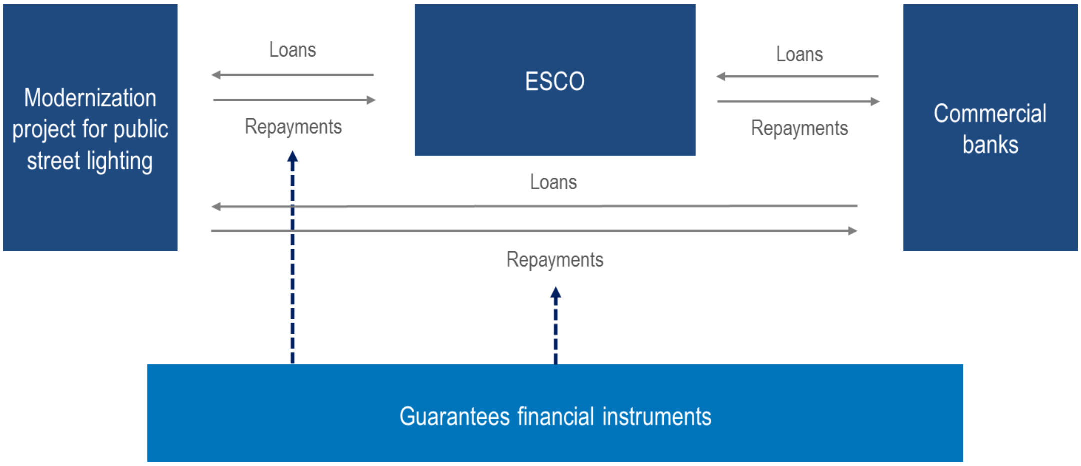
Project scope:

The eligible projects should deliver energy savings of at least 40% and have a payback period of at most 20 years. The eligible costs include replacement of lights, upgrading and/or installation of smart or advanced management and control system, and reconstruction or installation of distribution and power cabinets between 2014 and 2023 (Vaskelienė 2015).

Project implementation and outcomes:

Demand for such funding is very high: by the end of 2015, applications for funding street lighting projects cumulated to EUR 95 million for EUR 14.5 million available through the fund (Vaskelienė 2015). As of April 2017, the fund has approved two street lighting projects, further two were under evaluation and six more projects are in the initiation stage for a 50% guarantee of investment through ENEF (Laurusevicienе 2017).

Figure 9: Financing incentives provided by the Lithuanian Energy Efficiency Fund for municipal street lighting projects



Source: (Vaskeliene 2015).

3.2. Debt-based financing: issuing bonds

Model Overview:

Municipal bonds are issued by a local government (or their agencies) to raise funding for investment projects. When a municipality issues a bond, it means that it obtains a debt and must pay an interest and / or return the debt in the future. While municipal bonds can be used to finance any type of municipal investment, labelled green bonds are issued exclusively for sustainable and climate change related projects. To have a “green” label, such bonds need to be certified by an independent institution.

Advantages:

The municipality can raise finance for public projects autonomously or together with a bond agency. Typically, bonds have low interest rates, thus a bond offers capital to a lower cost than commercial bonds.

Disadvantages:

Issuing municipal bonds may imply extensive and costly preparation, e.g. obtaining a credit rating, approval from the national securities authorities, working with investment brokers. For this reason, many countries have municipal bond agencies, which aggregate the debt from multiple municipalities, issue bonds and sell them on the financial markets. Having high credit rating, such agencies can raise capital for the municipalities at lower cost than if the municipalities were to issue the bonds themselves. Apart from Sweden, such agencies are in Finland, France, Denmark, Switzerland, UK and the Netherlands (ManagEnergy 2017).

Projects that can be financed with this model:

Mostly municipalities having access to a bond agency could apply this model.

Jurisdictions that applied the model:

Bonds are less common in Europe, but widely used in the United States and the interest, especially for green bonds, is growing. The European examples include multiple cities in Sweden where the funding agency Kommuninvest provides financial resources to local municipalities using bonds. The city of Gothenburg, the second largest city in Sweden, was the first city to issue green bonds in 2013 (see the case study below). Its example was later followed by Paris, Johannesburg, Mexico, Oslo, Vasteras and multiple jurisdictions in the United States and Canada (Climate Bonds Initiative 2017). The American cases include federal and state level programs Qualified Energy Conservation Bonds (QECBs) as well as initiatives by the individual cities. For instance, Detroit and San Diego cities issued bonds to raise finance for modernisation of street lighting (LBNL 2012; Kinzey 2015).

Varna, the third largest city in Bulgaria (~335 thousand inhabitants), used municipal bonds to finance energy efficiency upgrades of the city's street lighting in 2002. The process was organised by a financial institution. The bonds were sold out within 24 hours and had positive financial implications for the project. The payback period was reduced to less than 3 years, and the interest municipality had to pay under the bond obligation (9%) was lower than the market interest rate charged by the banks (12-14%). The project delivered total annual savings up to 10,035 MWh, and in financial terms – EUR 512 thousand (ManagEnergy 2017).

Case study: Gothenburg Green Bond Program, Sweden

Context:

The city of Gothenburg started its green bond initiative in 2013. Since then the city issues green bonds to raise capital for climate change and environmental projects. The city has the Environmental and Climate Programmes, which set the emission and energy use reduction targets and define priorities in environmental and climate change actions (City of Gothenburg 2015b, 2015a). Green bonds help the city generate financial resources to implement these two programmes.

Project timing: 2013 – ongoing.

Key stakeholders:

- The City Council – develops the Environmental and Climate programmes and decides on the city's investment priorities
- The City Office - Urban Development and Treasury Departments – select projects for green bonds programme in line with the Environmental and Climate programmes
- The Environment Administration - verifies the project selection
- The City Executive Board – makes final approval of the projects for the green bonds programme (City of Gothenburg 2017).

Project scope:

Funding is not limited to one specific area, e.g. street lighting, but has a wider scope. Three groups of projects are supported with the green bonds programme – mitigation, adaptation and climate resilient growth, and sustainable environment. The last group can take only up to 20% of the total portfolio. Some examples of eligible activities include renewable energies and energy efficiency, waste and water management, biofuel, smart grids, sustainable transportation and housing. The projects have to be in line with the city's Environmental and Climate Programmes. They are selected by the City Office and approved by the City Executive Board (City of Gothenburg 2017).

Financing structure:

Gothenburg has been issuing bonds for last four years. They can be purchased on the capital market by any mainstream investor. In 2013, the first issue totalled SEK 500 million (EUR 56 million). In 2014, the second green bonds issue was SEK 1.81 billion (EUR 0.2 billion), and 2015 and 2016 issuances were SEK

1.05 billion (EUR 0.1 billion) and SEK 1 billion (EUR 0.1 billion) accordingly. The total capital raised via financial markets was SEK 4.36 billion (EUR 0.46 billion)[7] (UNFCCC 2016).

Project outcomes:

Since 2013, eleven projects have been financed with Gothenburg's green bonds. These include energy efficiency measures in traffic lights, electric cars, bicycle infrastructure, sustainable housing, district heating and other (City of Gothenburg 2016). Gothenburg was the first Scandinavian city and the first city in the world to issue green bonds.

3.3. Debt-based financing: engaging institutional investors

Model Overview:

Institutional investors include insurance companies, sovereign wealth funds, pension funds, mutual funds, and hedge funds, which invest into securities, real property or other type of assets over a long time horizon with low risk appetite. Institutional investors understand the risks of climate change and their interest in green projects is growing but the share of climate-friendly investment in the portfolios of EU institutional investors is only 1-2% (EC DG CLIMA 2015).

Institutional investors can be accessed in several ways. They invest in either publicly listed debt and equity, or dedicated investment funds and vehicles, for example, an energy efficiency fund that pools finance from multiple sources together and then invests in the individual projects. Institutional investors can also do direct project investments through debt, equity, public-private partnerships or other mechanisms (Kaminker et al. 2013). Institutional investors can be more easily engaged in those projects which include risk-sharing mechanisms, public guarantees and / or co-investment and other incentives from the government (IIGCC 2015).

Projects that can be financed with this model:

Climate-friendly or not, the investment has to meet certain financial criteria, because the primary goal of all institutional investors is to meet their financial obligations. To be attractive for the mainstream institutional investors, an energy efficiency investment project has to be competitive in terms of financial risk-return ratio without adjusting for climate-related risks (EC DG CLIMA 2015). Unless bundled for a sufficient investment scale, small-scale projects from individual municipalities will not be interesting for institutional investors.

Advantages:

The model provides access to a very large sum of money from investor groups, who rather look for long term investments with only moderate margins, but low risks, as well as a positive image.

Disadvantages:

For energy efficiency investments, there are still obstacles to engage intuitional investors at a larger scale. Heterogeneity of energy efficiency projects and immaturity of the market increases the transaction costs and makes energy efficiency less attractive than other investment options. Project bundling and standardising the project process, i.e. developing standardised contracts, monitoring, verification and reporting requirements, project rating approach, energy performance contracting and certification will help reduce the transaction costs. Financial sector regulation may impose additional limitations on energy efficiency investment.

[7] SEK / EUR currency conversions were calculated according to the historical exchange rates available at the European Central Bank at the end of 2013, 2014, 2015 and 2016: https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-sek.en.html

Jurisdictions that applied the model:

See case study below.

Case study - The London Green Fund (LGF)

Context:

London has an ambitious goal to reduce its emissions to 60% below 1990 levels. Facing environmental pressure, the city's Economic Development Strategy has a strong focus on environment. The London Green Fund is one of the city's initiatives to develop green infrastructure. It was set up as a holding fund to implement operational programme from the ERDF to support urban development projects and leveraged four-fold additional investments, including institutional investors. The fund was set up with technical assistance from JESSICA initiative (Joint European Support for Sustainable Investment in City Areas).

Project timing: 2009 – 2015.

Project scope:

The LGF is a £110 million (EUR 130 million) holding fund that consists of three urban development funds, focusing on waste (Foresight Environmental Fund, FEF), energy efficiency (London Energy Efficiency Fund, LEEF) and social housing (Greener Social Housing Fund, GSHF). Apart from the LGF finance, three funds also receive direct investment from the private sector or third parties. Each of the funds supports viable but not yet commercially attractive projects from public and private actors that help meeting London's environmental targets (EIB 2015).

Each in its priority area, three urban development funds provide loans and equity. The LEEF offers loans for investments of £3-10 million (EUR 4-12 million), with special cases for projects under or beyond this investment volume and additional financial instruments available depending on the project structure. The FEF provides equity, and the GSHF offset loans to providers of social housing (EIB 2015).

Financing structure:

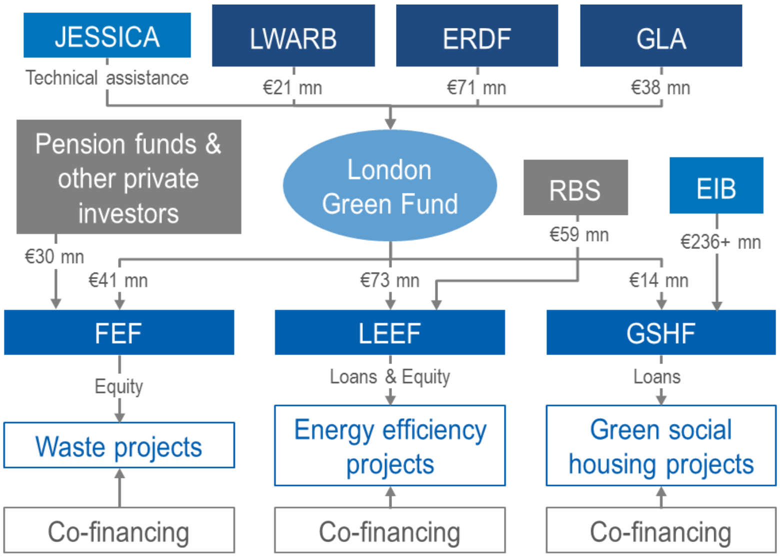
The LGF pooled together EUR 130 million from three public sources: ERDF, Greater London Authority (GLA) and London Waste and Recycling Board (LWARB). These resources were split between three urban development funds. The three funds raised additional finance from private investors for a total amount of EUR 326 million. In addition, the International Public Partnerships (INPP) would provide EUR 24 million to the LEEF for equity investments. The total funding available was EUR 480 million.

The funds have revolving nature. The interest and loan repayments will be returned to the LGF and re-invested it the future urban development projects. Setting up a revolving fund to absorb the ERDF resources helped to leverage significant amount of private capital. The leverage ratio of ERDF funds is 6.8 and the leverage ratio of all public resources is 3.7 (EIB 2015). The summary of the financing structure is presented in Figure 10.

Key stakeholders:

- Intermediate Body: Greater London Authority
- Funding partners: Greater London Authority, London Waste and Recycling Board
- Private investors: Royal Bank of Scotland, International Public Partners, Pension Funds, individuals and syndicates, European Investment Bank
- Holding Fund Manager: European Investment Bank
- UDF Fund Managers: Foresight Group, Amber Infrastructure Ltd., The Housing Finance Corporation

Figure 10: Financing structure of the London Green Fund



Source: (EIB 2015).

Project outcomes:

Currently 15 projects for a total project value of £678 million (EUR 800 million) received funding from the LGF for a total amount of £ 99.4 million (EUR 117 million). Investments are expected to reduce emissions in the amount of 215,000 tonnes per annum CO2, create over 2,000 jobs and save 330,000 tonnes per annum waste to landfill (EIB 2015).

4. Financing by a private contractor

Alternatively, municipal actors could reallocate the burden of financing street lighting infrastructure on third parties, e.g. contracting an energy service company. The next section focusses on those models, where the financing is covered by a private partner, for instance an energy service company (ESCO), who delivers the upgrade works and who usually is not responsible for energy supply and therefore cannot use energy savings for his financing needs. The private partner finances the street lighting project from its own funds or it obtains the funds from third parties. For its services, the contractor receives the payment from municipalities. If the contractor obtains financing from further third parties, it returns the debt to them. The municipal payment to the contractor and the contractor's payments to a lender are not contingent on energy savings occurring.

4.1. Simple contracting model

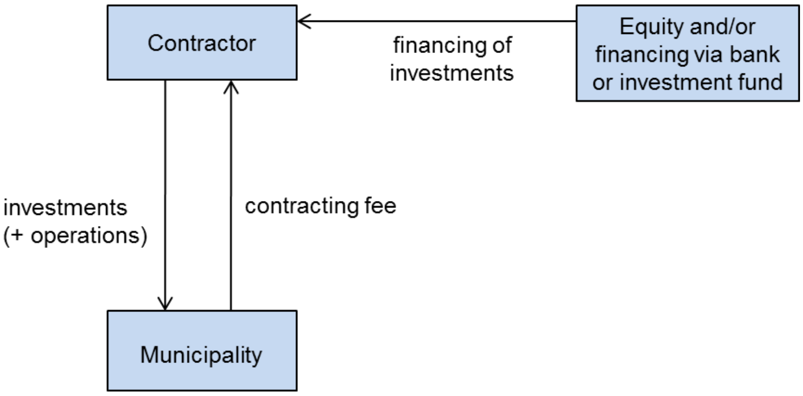
Model overview:

In literature, the term "contracting" is used for a variety of models. Quite often, it is used for models, where energy savings are utilized to cover the investment costs into new, energy efficient street lighting technology. Such models are described in the following chapter (5). In chapter 0, however, it is focussed on those models, where the financing is covered by a private partner, who usually is not responsible for energy supply and therefore cannot use savings for his financing needs.

In a simple contracting model, shown in Figure 11, the contractor can have several responsibilities, but its main activities are usually planning, financing and execution of the investment into a new, energy efficient street lighting infrastructure. Optionally, the contractor could also be responsible for the operation of this infrastructure. There are, however, several reasons, why this usually is not the case. First of all, the city usually either has its own resources for the operation of the street lighting infrastructure, potentially supported by sub-contractors, or already has assigned an external operator with this task in a contract, usually running over a longer period. Such contracts often do not cover modernisation using new technology. For this reason, the city either has to wait until the end of the contract, in order to tender a different contract including modernisation, or a different partner has to be found for the modernisation. Since the most suitable timing of the investment usually does not coincide with the end of an existing operation contract, the latter case, namely finding a different partner for the modernisation, often makes sense.

In a simple contracting model, the contractor directly receives a contracting fee, which covers the costs of planning, financing and execution of the investment, and obviously includes a margin. The length of such a contract may vary, depending on the size of the investment, its relation to energy costs etc., but it typically is in the range of ten years or more. The contract usually has to be put out to tender, and there are different options how to evaluate the offers received by various bidders. The city might define the framework conditions like minimum energy savings to be achieved, details about the luminaires to be used, warranty conditions, standards to be met, etc. In addition, the procedure at the end of the contract needs to be defined. Theoretically, the contractor should have the opportunity to remove the luminaires at the end of the contract. Due to the long running time of such contracts, however, it is very unlikely that this will take place, because relatively old luminaires are of no use for the contractor, since he will not be able to sell them again.

Figure 11: Simple contracting model



Source: Authors' own figure.

Typically, tenders are evaluated based on the savings the city achieves. Such savings can be significant, particularly in countries with relatively high energy prices. The contracting fee, to be paid by the city to the contractor, in such cases usually is much lower than the energy savings achieved. In addition, costs of maintenance are reduced as well, due to the low maintenance costs of modern light-emitting diode (LED) luminaires.

Projects that can be financed with this model:

Projects need to have a sensible minimum size, in order to justify the set-up of the model by the contractor, who often involves a bank for co-financing. There is no fixed threshold, but EUR 0.5 - 1 million may be the minimum project volume. A higher level would be needed, if the contractor also becomes responsible for carrying out the operations, because in this case it is necessary to establish an office with personnel and equipment in – or close to – the city.

Advantages:

The key advantage is that the model is off-balance sheet for the city. It makes contracting models different from loans, since the latter are normally on-balance sheet for the city. It is therefore recommended to clarify this issue with the responsible authority, which the city has to report to. A further advantage is that specialised companies can be selected via the tendering process, who have corresponding know-how and experience, and who will offer more attractive prices than the city itself or the existing operator might achieve.

Disadvantages:

The major disadvantage, from a city viewpoint, is the high financing costs of such model. Costs of the contractor's capital – either directly if equity is used, or via re-financing through a bank –is usually significantly higher than in the case of direct financing from the city's budget, or in case of financing through models with low interest rates. A further disadvantage can be that there are restrictions in the availability of grants. This has to be checked within the specific programme. For example, in Germany the grants available from the German federal government until 2017 could not be used for contracting models. From a contractor's viewpoint, it is a disadvantage that this model is on-balance sheet, while typically, private investors favour off-balance sheet models.

Jurisdictions that have applied the model:

Simple contracting models are being widely applied in street lighting, although both partners (city and contractor) usually search for ways to reduce the financing costs by applying more complex models like the one described in the following section (4.2).

4.2. Contracting model with forfeiting and waiver of defence

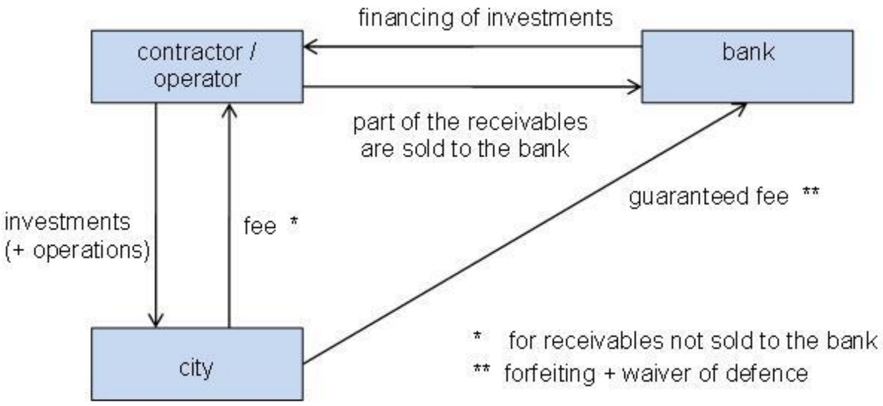
In this more complex model, the roles of the city and the contractor are similar to the simple contracting model described above. The major difference is that the involvement of a bank is a central element of this model, and that the bank enters into agreements both with the contractor and with the city (Figure 12).

The contractor sells part of the future receivables to a bank that referred to a forfeiting transaction. In this particular case it means that the city has to pay part of the contracting fee to the contractor, and another (typically larger) part not to the contractor but directly to the bank (forfeiter). The part of the receivables, sold to the bank, corresponds to the value of the equipment installed, and therefore is higher than the part for planning, installation and warranty.

Whereas the bank participates in the risks arising from uncertainties associated with the receivables, it earns a margin. In this particular model, the city may provide a guarantee to the bank, referred to a waiver of defence. According to it, the bank minimizes its risks requesting a guaranteed fee from the city, even in case of the worst scenario, e.g. even if all luminaries are not functioning and thus no energy savings occur. All risks associated with the performance of the equipment and other possible risks are carried by the contractor.

The contracting model with forfeiting and waiver of defence therefore allows raising finance while minimizing the risks to the bank and therefore reducing the interest rate to a level, which typically is available for municipalities only. While the difference of a few percentage points might seem relatively low, this could add up to quite a sum over the long running time of a contracting contract.

Figure 12: Contracting model with forfeiting and waiver of defence



Source: Authors' own figure.

Similar to the previous model, the contractor are the owners of luminaries for the contracting period of time. At the end of the contract there should be an option for the contractor to remove the luminaries. If this is not the case, than the further use of these luminaries by the municipalities should be regulated by a leasing contract.

Case study: Dillenburg, Germany

Context:

In 2011, the German city of Dillenburg tendered the contracting of part of their street lights, based on a structure with a high share of some 73% of all luminaires using high pressure mercury (HPM) lamps. The energy efficiency of these lamps is low, and it had already been decided at that time by the EU to phase out the utilisation of HPM lamps through a directive banning sales as from 2015. A contracting model for Dillenburg was interesting, because replacement of HPM based street lights was urgent, while there were budgetary constraints on financing this replacement in the short term. The main goal therefore was to spread the costs over a 12-year period, and to find a specialist for the modernisation task, while the responsibility for operations should remain with the utility of Dillenburg.

The contract was tendered in 2011 in a process with multiple steps, including an indicative analysis and concept to be presented by bidders, followed by a preliminary contract and a detailed analysis and concept, which then were used for the final contract. The final decision was mainly based on the maximum reduction of annual costs for the city, consisting of the contracting fee and energy costs of the street lighting infrastructure.

Some 70 % of receivables were sold by the contractor to a bank, which then became a third partner to the contract in order to enable forfeiting and the waiver of defence. The 12-year contract started in September 2012, and the replacement of some 2,450 luminaires took place in less than three months.

An additional element of this particular contract is that the successful bidder guaranteed a certain level of energy savings (minimum 52 %), contributing to the reduction of the city's annual costs. If the contractor achieves higher savings than guaranteed, the additional savings are split between the city of Dillenburg and the contractor. The exact split was part of the successful offer and leads to an additional contribution towards the reduction of the city's annual costs. In total, annual energy savings amount to some 1 GWh or EUR 160,000, which is much more than the payments to the contractor and the bank.

Project timeframe: 2012 – 2024.

Project scope: energy efficient modernisation of 2,450 luminaries.

Key stakeholders:

- Client: city of Dillenburg, Germany;
- Contractor: SWARCO V.S.M GmbH;
- Bank: Commerz Real Mobilien Leasing GmbH.

Financing structure:

Financing of the project was implemented off-balance for the city. The contractor sold some 70% of receivables to a bank which receives guaranteed payments from the city over a 12 year period (forfeiting and waiver of defence).

Project implementation and outcomes:

Replacement of old luminaries with new energy efficient luminaries took place in less than three months. The contract is still running but so far, energy savings have been higher than guaranteed by the contractor. The contractor therefore receives a part of the additional savings as agreed in the contract.

Case study: Litomysl, Czechia

Context:
Litomysl is a town and municipality in the Pardubice Region of Bohemia in the Czech Republic, inhabited by 10,777 people. The town of Litomysl is listed as a UNESCO world heritage site and therefore the retrofit of its infrastructure should comply not only with high energy performance standards but also with national heritage rules. The municipality issued a tender for energy performance contracting of an energy service company that would implement an upgrade of city infrastructure, including the upgrade of street

lighting, guaranteeing energy savings and complying with the national heritage preservation standards. The local energy service company, PORSENNA ops, won the tender and provided the installation works.

Project timeframe: the contract running time is 2014 – 2024.

Key stakeholders:

- Client: the municipality of Litomysl
- Contractor: ESCO PORSENNA ops
- Bank:??

Project scope: among other measures, the project covers the replacement of four public lighting racks, the replacement of 1,225 high pressure sodium luminaries for LEDs with night-time dimming, and a system of traffic monitoring and remote control online in real time. The latter measure was first time ever used in Czechia (ref).

Financing structure:

Financing of the project was implemented off-balance for the city and on-balance for the ESCO with the ESCO bearing all technical and financial risks associated with the project. An EPC contract was for ten years from 2014 until 2024 was concluded between three parties the municipality of Litomysl, Porsenn, and the bank name xx. According to the contract, the actual installation works had to be implemented in 2014 – 2016.

Porsenna guaranteed that it will achieve a minimum of xx% of energy savings that would reduce energy costs of the town of Litomysl. To cover the project investment cost, Porsenna obtained a loan from the bank. Porsenna sold xx% of the future receivables to the bank, therefore these payments have been made directly from the municipality to the bank from its guaranteed energy savings as set in the EPC agreement. As the bank has a guaranteed cash inflow over 10 years from the municipality, it could allow for a lower interest rate than it would be otherwise. In that way Porsenna has a much shorter payback period on its investment.

Project implementation and outcomes:

The retrofitting of the public lighting infrastructure lead to annual cost savings of the city of ca. EUR 72,000 or ca. 26.4% of the energy costs before the retrofit.

5. Financing by private partner through energy savings

Energy Performance Contracts (EPCs) are used to finance municipal infrastructure projects by private partner, usually an Energy Service Company (ESCO) through energy savings. There are different descriptions and models of EPCs. The basic element of all EPC models, however, is that cost savings achieved via a reduction of energy consumption, are used to finance the investment. EPC models work in both cases with the municipality or the private partner being responsible for energy supply. In the end, however, it always will be the municipality paying for the service of operations including energy supply, plus planning, financing and installing the new equipment, either directly for each of these services, or in a lump sum.

Two elements can categorize the EPC models. The first is the provisions on energy savings to be achieved and how they are to be shared between the contractor (ESCO) and the municipality. Here municipalities can choose between the guaranteed savings EPC model and shared savings EPC model.

The second element is how the upgrades or modernization works will be distributed over time, e.g. whether all modernization will take place in the first years of the contract to achieve maximum energy savings, or rather stretched over time. In this case, municipalities can choose either a modernization contract with immediate savings of energy costs or EPC with staggered modernization. All four EPC models are discussed in the following sections.

5.1. EPC – garanteed savings model

Model overview:

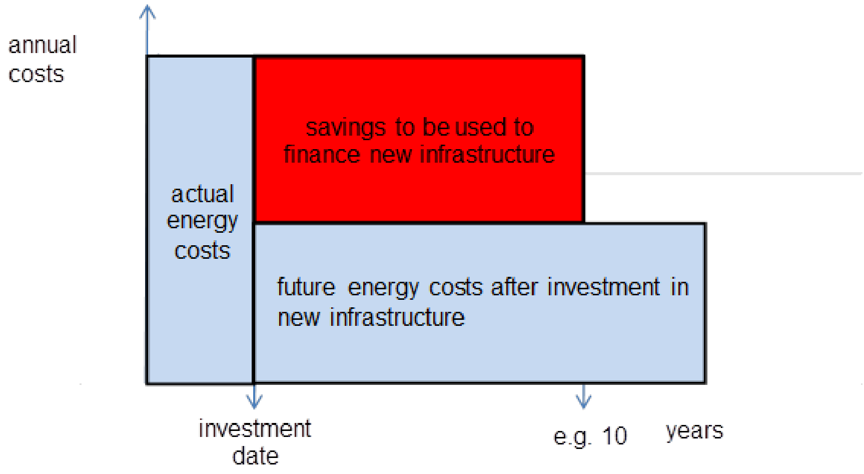
EPC with guaranteed energy savings implies that the ESCO designs and implements the project, and is obliged to achieve a certain level of energy savings. If the ESCO fails to deliver guaranteed level of energy savings it has to cover the shortfall. In case ESCO delivers higher energy savings than guaranteed, they fully benefit the municipality. The municipality pays a fixed fee over the contract term from the saved energy bills.

Energy savings should, however, be sufficient to pay for the modernisation in a reasonable time. This already shows a potential problem of this model. In countries with low energy prices, the payback period can be too long to find private partners willing to enter into such contracts. Experience has shown that this was the case in some Eastern European countries, with energy prices far below 10 EUR-Cent/kWh[8]. It leads to theoretical lengths of energy performance contracts of more than 20 years, whereas in a typical Western European country with energy prices close to or even beyond 20 EUR-Cent/kWh, much shorter contract lengths are possible.

In the model shown in Figure 13, future costs for the municipality, consisting of energy costs plus regular payments to the private partner, are identical to the energy costs paid by the municipality before the modernisation took place. When rather old lighting technology is replaced with state-of-the-art LED luminaries together with “intelligent” controls, such upgrades can deliver energy savings up to 80% or more. In this case, municipalities can use significant part of the cost savings to cover their EPC fees to the service provider. This can be used in two ways: either to shorten the length of the contract, or to reduce regular payments of the municipality, allowing immediate savings, even during the term of the contract, as shown in Figure 14.

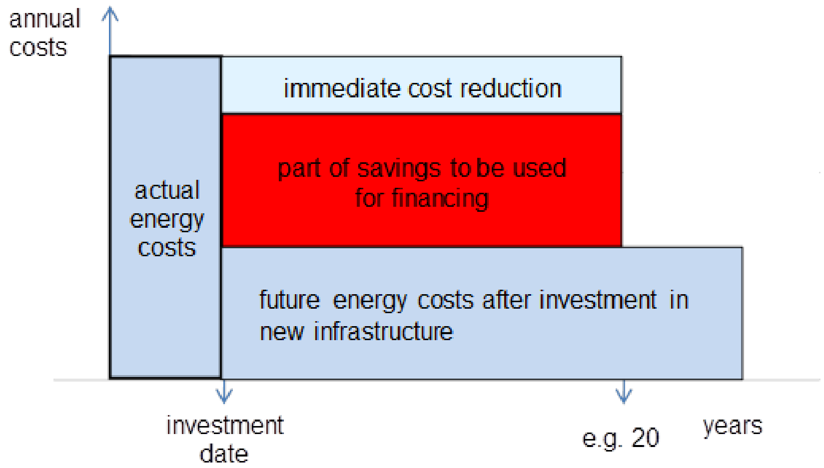
[8] As of September 2017, the electricity price for municipalizes was ca 0.106 EUR cent/kWH in the Czech Republic and ca 0.092 in Croatia (responses to questionnaire 1)

Figure 13: EPC – guaranteed savings model (time optimised)



Source: Authors' own figure.

Figure 14: EPC – guaranteed savings model (with immediate cost reductions)



Source: Authors' own figure.

For all models, subsumed under the term EPC, a basic element is the guarantee of the private partner to achieve a certain level of energy savings. For the municipality, this is helpful to calculate future costs with a high reliability, because the risk of achieving the energy savings is transferred to the private partner. Typically, there also is an arrangement, under which payments to the private partner will be cut, if he does not meet the guaranteed savings. While theoretically this constitutes a risk for the private partner, the company might include a buffer in its calculation of energy savings and include this in the offer.

Projects that can be financed with this model:

This model is suitable for projects with a high energy (cost) savings potential. Otherwise, the contract length could be too long to attract private partners. Moreover, municipalities should have sufficient financial resources to pay the same – or a slightly reduced - amount of money in total over the length of the contract, although now split between energy costs and payments to the private partner.

Advantages:

Key advantage is that the city will receive a new, energy efficient street lighting infrastructure, without any peaks in public spending. Payments are constant, possibly even on a slightly reduced level than before, and after expiry of the contract, the city owns an energy efficient infrastructure and benefits from the low operating costs. A further advantage for the city is the wide ranging transfer of risks to the private partner.

Disadvantages:

Some disadvantages have been described above, related to low energy prices and/or the efficiency of the existing lighting infrastructure. In many Eastern European countries, high pressure sodium (HPS, yellow light) lamps dominate the existing street lighting infrastructure, leading to lower – while still significant – energy savings of up to 60 %, depending on the age of the technology in use. Unfortunately, this often coincides with low energy prices. A further disadvantage of this model is a missing incentive for the private partner to reduce energy demand more than guaranteed in the contract. This problem can be solved with the “shared energy savings” model presented in the next section.

Jurisdictions that have applied the model:

Several variations of this model have been applied e.g. in Germany.

Case study: project bundling in the province of Huelva, Spain

Context:

The project scale is the major challenge for municipalities, especially for the smaller ones whose individual projects are often too small to raise interest from ESCOs. Bundling projects or having a grouped tendering process that covers several municipalities can provide a solution to this challenge. The Provincial Diputación of Huelva (DIPH) developed and implemented a “Grouped Tendering Process for the Efficient Management of Public Lighting in Municipalities in the Province of Huelva”. This approach allows bundling projects of several municipalities and tendering them as a group.

Grouped tendering provides several advantages. For small municipalities with limited resources and project scale, grouped tendering delivers economies of scale and makes the projects more financially viable. As a group, municipalities can access services and resources at more competitive prices, the contract duration is shorter and annual fees charged by the service providers are lower.

Spanish province of Huelva consists of 79 municipalities with around 520 thousand inhabitants. Most of the municipalities have less than 5,000 inhabitants, and some are with less than 1000 inhabitants. Public lighting in the province was considered to have inadequate levels of illumination, high level of energy consumption and costs, as well as maintenance cost (Diputacion de Huelva 2016).

Project timing: 2015/2016 for 12 years.

Key stakeholders:

- Provincial Diputación of Huelva (DIPH) – technical assistance and tender management;
- Huelva Provincial Energy Agency (APEH) – technical assistance;
- 9 municipalities in the Province of Huelva: Almonaster La Real, Cala, Calañas, El Campillo, Campofrío, Chucena, Jabugo, Puebla de Guzmán and Villarrasa;
- ESCO Gamma Solutions SL – contractor, service provider.

Project scope:

The project covers 9 municipalities and includes works and services in public lighting. The ESCO Gamma Solutions SL was awarded the contract through the tendering process. The type of contract is “Mixed Services and Supply with an open adjudication Procedure” for EUR 7.1 million and average energy savings of 72.9 %. It is a mixture of energy service contract and energy performance contract with guaranteed energy savings. It includes delivery of four main services:

- energy management of public street lighting installations;
- preventative maintenance, inspections and verifications;
- total guarantee of all repairs or replacements necessary due to acts of vandalisms or outside causes;
- improvement and renovation of public street lighting and investment in energy efficiency and delivering a certain guaranteed level of savings. If energy savings exceed the guaranteed levels, they are shared amongst the municipalities.

The project includes replacement of all lighting with LED technology and energy efficient controls, monitoring of installations, installation of atomic clocks for controlling times of operation, putting in order all supports, revision and installation of appropriate grounding in all points. Investment projects were assessed and grouped according to three main criteria: geographical proximity of municipality and links to supra-municipal structures; investment volume per municipality; and financial solvency of the municipality.

In 2012, at the beginning the project had a wider scope. Consultations were held with 78-79 municipalities and three priority areas were discussed: public lighting, public buildings and renewable energy sources. After three years of assessments and consultations, the final scope was narrowed to public lighting in 9 municipalities (Diputacion de Huelva 2016). It points to the main drawback of this approach – complexity of bundling different projects and municipality profiles, and finding a solution that works for all.

Procurement and financing structure

Grouped tendering brings in legal, coordination and liability challenges. Which institution will serve as a procurement body without setting up a new regulatory body was the corner stone of choosing the procurement and financing model for the project. Several models were considered, namely:

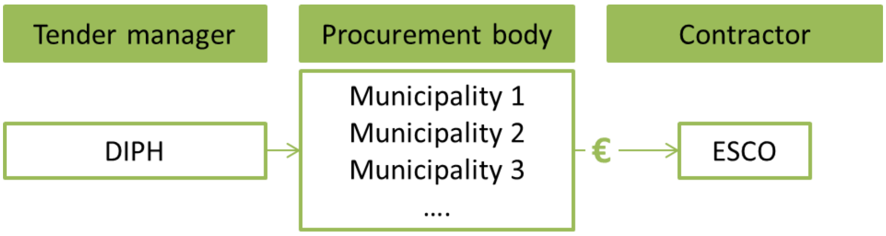
a) DIPH serves as a procurement body;
b) groups of municipalities act collectively as one procurement body, with DIPH technical assistance;
c) association of municipalities, either existing or set up for the project, with DIPH advisory and technical assistance;
d) a "local consortium" as a legal public entity set up for the role of procurement body, with DIPH technical assistance;
e) groups of municipalities acting individually as procurement body but with the technical assistance of the DIPH.

Option e) presented in Figure 15 was selected for project implementation. In this model the municipalities are grouped and each group acts as a separate procurement body. They delegate the call-for-tenders process to the DIPH. DIPH acts as a tender manager and develops technical requirements, draws tender documents, designs the award criteria approved by each municipality, publishes the calls and evaluates submitted tenders. Each municipality then signs an individual contract with ESCO (Diputacion de Huelva 2016).

Project outcomes:

Direct expected outcomes of the project are emission reductions in the amount of 5.8 t $CO_{2\text{-eq.}}$/year, energy savings of 11.0 GWh/year, cost reductions over EUR 1.7 million and 100 new jobs created. Aside from that, grouping helped the municipalities implement their projects at better contracting terms and realise projects that might not have been financially viable otherwise. The project also generated a lot of insights and useful data on energy service contracting in each municipality (Diputacion de Huelva 2016).

Figure 15: Procurement and financing structure of the project bundling in the province of Huelva



Source: (Diputacion de Huelva 2016).

Case study: project bundling in the cities and municipalities of Krapina-Zagorje and Zagreb County

Context:

The Krapina-Zagorje County and Zagreb County surround Zagreb, the capital of Croatia, and account for 11% of the total country's population. Being in the centre of the country, this region is a crossroad of major roads, railways and pipelines. It is also the industrial heart of Croatia. Among a package of energy strategies and actions plans for the these counties, the North-West Croatia Regional Energy Agency (REGEA) designed a masterplan for street lighting. The plan contains the assessment of technological and economic potential associated with efficient street lighting as well as identifies financing options for street light retrofits. The agency also developed a methodology for energy audits of individual street lighting projects. The NEWLIGHT project aims to assist the implementation of this masterplan and deliver the retrofit of public lighting infrastucture.

The NEWLIGHT project provides municipalities with assistance for the preparation of a) tender documentation to select a contractor for energy audits; b) energy audits themselves providing detailed energy assessment of public lighting status quo for all self-government units; b) design of lighting system upgrades including technical backgrounds and guidelines for designing public lighting upgrades, e.g. action plans for the implementation of these upgrades; d) tender documentation for the selection of a contractor to implement these upgrades.

Project timing: 2015 - 2018

Key stakeholders:

The NEWLIGHT project is implemented by REGEA under the European Local Energy Assistance (ELENA) instrument. REGEA aims to promote and encourage regional sustainable energy development through renewable energy and energy efficiency projects implementation in 57 municipalities based in Zagreb County and Krapina-Zagorje County. After energy audits and assessment of the status quo, REGEA draws up, with each individual city and municipality, an action plan including the plan for modernization, reconstruction and management of public lighting system; assessment of potential sources of funding; and identification of optimal financing models.

ELENA instrument was established by the European Commission (EC) as well as the European Investment Bank (EIB) in order to mobilise investments for sustainable energy projects at local level and it is funded by the Horizon 2020 Programme of the EC. ELENA enhances the capacity of local authorities to develop investment programmes and implement economically feasible projects by providing the funding to prepare these projects and programmes for financing and implementation. For more details on ELENA, please see deliverable D.T2.3.2 of the Dynamic Light project on analysis of funding sources for street lighting.

The NEWLIGHT projects tendered the contracts and awards them to different contractors, including ESCOs. REGEA and municipalities carry the responsibility that contractors replace old luminaries with energy-efficient technologies such as LEDs, install advanced light control systems, and provide auxiliary works such as replacement of poles and replacement of power cables in.

Project scope:

The project upgrades street lighting in 57 cities and municipalities in Krapina-Zagorje County and Zagreb County. The scope of the project is to replace 34.000 luminaires and build 3.500 new poles (ref.).

Financing structure:

REGEA and ELENA signed a contract to implement the NEWLIGHT project that would provide technical assistance to municipalities on how to implement street lighting retrofits. The total value of the contract is EUR 790,000, of which EUR 711,000 was financed by EIB through the ELENA instrument, EUR 51,800 by Zagreb Country, and EUR 27,200 by Krapina-Zagorje County (ref).

Further, the trilateral agreement was signed between Krapina-Zagorje County, Zagreb County, and REGEA to define the terms of work under the NEWLIGHT project. The total investment volume of required by upgrades of street lighting infrastructure is EUR 20 million (ref). Depending on the municipality's financial situation, REGEA suggests municipalities using either of three financing models (ref):

1. a municipality awards a contract to a contractor through a tender for the installation of solutions described paying from its own budget;
2. a municipality contracts an ESCO applying an energy performance contracting model with guaranteed savings where the ESCO bears technical and financial risks;
3. a municipality enters a public private partnership (PPP) other than energy performance contracting and share the risks.

The details of PPP agreements, including EPC, are developed based on the Energy Efficiency and Public Private Partnership Contract Model provided by REGEA within the NEWLIGHT project. According to this model, the contract terminates once the investment costs were repaid, typically within five to eight years.

Project outcomes:

The estimated energy savings of the project are up to 60% as compared to the previous consumption levels of municipalities for street lighting that corresponds to ca. 9,5 GWh and 2,800 tCO_2. These energy savings translate to ca. EUR 1.8 million/yr. (ref)

5.2. EPC – shared savings model

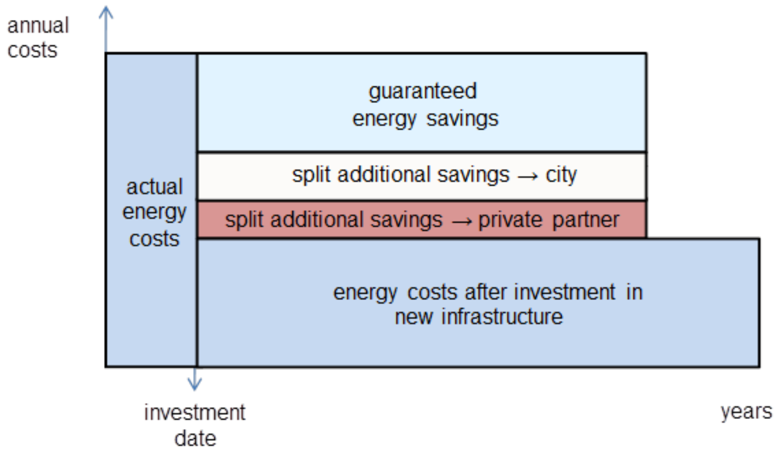
Model overview:

In this model, both partners, a municipality and a private partner, benefit from additional energy savings, realised on top of the guaranteed savings level. This is a "win-win-situation", when both a contractor and a municipality are interested in as high energy savings as possible, and is therefore found more often than the guaranteed EPC models.

The contract includes typically a certain level of guaranteed energy savings, as well as a malus agreement, cutting payments to the private partner if the guaranteed savings are not met. In addition, the municipality and the private partner share any additional savings, achieved on top of the guaranteed level. The bonus payment to the private partner can be either a certain amount in EUR/MWh, or a share of the saved energy costs, based on an electricity price agreed upon by both partners. Such a model provides a transparent incentive for additional energy savings on both sides, with a clear split (Figure 16).

The split might be 50%/50%, but it can also be a different one. It is possible, e.g., to ask bidders in the tendering process to propose a split in their offers.

Figure 16: Energy performance contracting – shared savings model



Source: Authors' own figure.

Projects that can be financed with this model:

The same criteria as described in the section 5.1 apply to this model. It is suitable only in cases where the energy savings potential is high, because otherwise, the amortisation period is too long.

Advantages:

A big advantage with this model is that there is an incentive on both sides to consider and realise additional energy savings, even if these were not planned or foreseen in the first instance. Since municipalities receive a share of additional energy cost savings, this allows them making additional investment into energy efficiency projects. The model also possesses the advantages of the model described before.

Disadvantages:

While the disadvantage of guaranteed energy savings models without sharing additional savings, namely lack of incentive to reach energy savings beyond guaranteed levels, has been solved, the other disadvantages in case of low energy prices and therefore long payback periods still exist.

Jurisdictions that have applied the model:

The model was applied in Germany. Please see the case study below for more insights.

Case study: the city of Nauen, Germany

Context:

In 2010 the German city of Nauen tendered a 5-year contract for the operation of their street lighting infrastructure, consisting of some 2,350 luminaires, some 45% of which were equipped with HPM lamps, whereas the rest were HPS lamps. Targets set by the city were a complete replacement of HPM based luminaires by more efficient technology (not necessarily LED), energy savings of at least40 %, and a limitation of investment needs due to budgetary constraints. Alternative bids with varying details were invited too.

Several bids were received and evaluated based on the total operating and investment costs. From the successful bidder, the city of Nauen received two offers, one for a period of 5 years, the other one for period of 10 years. While the first one guaranteed energy savings of at least 43 %, but with limited modernisation measures and not including LED technology, the second one went a step further in terms of more advanced technology, leading to energy savings of at least 47 %. After considering all offers received, as well as the budgetary situation, the city decided to accept the first offer, mainly because of the lower investment volume.

The city did, however, want to keep the option open for additional investments in more efficient lighting technology, in case the city's budget would allow this in later years. Therefore, an agreement was reached that additional energy savings, on top of the 43 % being guaranteed, should be split 50% /50 % between the city of Nauen and the private partner. Based on an electricity price per kWh fixed at the beginning of the contract, any additional energy savings were measured once a year, with 50 % being paid to the private partner. As a result of this agreement, some additional investments in energy efficient technology were carried out, proving the "win-win" character of the model.

Project timeframe: 2011 – 2016.

Project scope: modernization and operation of the street lighting infrastructure.

Key stakeholders:

- Customer: city of Nauen, Germany
- Contractor: SWARCO V.S.M. GmbH

Financing structure:

Payments came from the city but were compensated by the energy savings.

Project implementation and outcomes:

The private partner responsible for operations and the modernization achieved slightly higher energy savings than guaranteed, and therefore received additional payments, because the contact provided for a split of additional energy savings between the city and the private partner.

5.3. Other EPC models

5.3.1. Modernization with immediate savings of energy costs

Model overview:

In reality, investments in new, energy efficient street lighting infrastructure could be carried out in the space of a few months, unless the total volume is too large. It might be stretched over a slightly longer period, which, however, should be as short as possible, in order to benefit from the energy savings as soon as possible. The EPC can be either with guaranteed savings only or with shared savings provisions.

Projects that can be financed with this model:

Models with immediate realisation of modernisation (meaning carrying out replacement of old luminaries by new energy efficient luminaries in a period as short as possible) are suitable if all existing luminaries are old and no longer acceptable in terms of energy efficiency, reliability and maintenance cost.

Advantages:

The key advantage of this model is the maximisation of energy savings. Moreover, as new technologies in general, and LED technologies in particular, are characterised by reduced maintenance needs, corresponding costs are lower too, which should be reflected in the price offered by the private partner.

Disadvantages:

If the city is paying for the modernisation itself, then investment costs in the initial phase might be a big burden. Moreover, there will be a lot of modernisation activity in the city at the same time. It has to be considered, if this is acceptable in terms of traffic congestion and public acceptance, particularly if poles are to be replaced, not just luminaires.

In long running contracts, the early realisation of the investment means that the entire street lighting infrastructure at the end of the contract is “old” again and needs to be replaced again. Until then, no modernisation takes place, so that there is no chance to modernise at a constant rate – typically 3% of the existing infrastructure per year – always using the most advanced technology. All luminaires will be modernised at the same time, regardless of their age, although some still might be in a reasonable condition. These disadvantages are eliminated in the model described in the next section, realising a time optimised – meaning stretched over a longer period – modernisation and utilisation of energy savings.

Jurisdictions that have applied the model:

The EPC guaranteed savings model with immediate savings of energy costs was implemented in several European cities. For instance, the city of Tona in Spain used the model to upgrade a total of 2,025 luminaires and install a remote control system in the year of 2012 leading to annual savings of EUR 58,966 per year (GuarantEE 2017b). In the Sapareva bania Municipality in Bulgaria, 1,381 lamps were replaced by LED lights in 2015 and 2016 leading to EUR 93,335 in terms of saved energy costs per year (GuarantEE 2017c). The Berliner Energieagentur GmbH has reported the successful implementation of 10 such projects in 2003-2004 with the Clearinghouse for Energy Contracting in Central and Eastern Europe and 17 such projects in 2005-2007 with the EuroContract Guaranteed Energy Performance (Geissler 2013).

Case study: the city of Graz, Austria

Context:

There are 25,000 luminaires in the city of Graz, out of which over 700 were upgraded in 2005, in the frame of the Greenlight 1 project. Most luminaires still dated back from the 1960s resulting in energy costs of EUR 1.1 million (with tax) per year. Following the successful execution of this pilot project, the city of Graz implemented a similar project on a larger scale in 2007. This time, 18,000 luminaires were upgraded within three years within the frame of the Green Light Graz 2010 project (Energie Graz GmbH & Co KG 2010; GuarantEE 2017a). The city’s aim was to implement the energy efficiency measure as fast as possible so to maximise the energy savings and saved energy costs. The luminaires were replaced by energy efficient high pressure sodium vapour lamps. Aluminium die-cast luminaires with protection class IP66, reflectors and easy shutters for bulb replacement were installed and a switching and lowering control system was implemented.

Project timeframe: 2007 – 2010.

Project scope: 18,000 luminaires.

Key stakeholders:

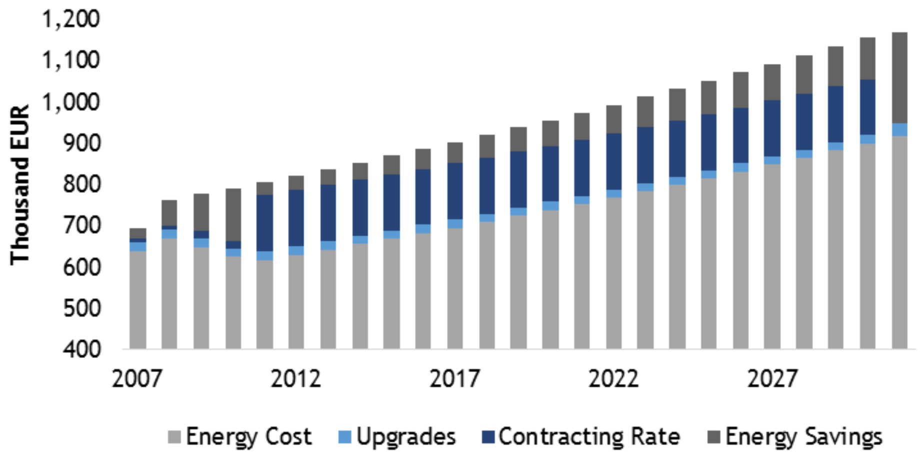
- Contractor: Energie Graz (the energy service provider);
- Customer: the city of Graz;
- Project manager: Graz Energy Agency (Graz Energieagentur).

Financing structure:

The project was financed within the frame of the Thermoprofit® energy performance contracting programme designed and implemented by the City of Graz and the Graz Energy Agency. The Graz Energy

Agency was contracted by the city of Graz for the contract design, general management and control over the project implementation. The local utility providing service and maintenance of street lighting, Energie Graz, served as an ESCO and was contracted by the city of Graz for technical design of the street lighting upgrade, financing and implementation of the project. The investment costs were EUR 2.3 million. Energie Graz guaranteed to the city of Graz a minimum energy savings of 20%; in reality the energy savings achieved as of 2011 were 24%. The city of Graz paid to Energie Graz a monthly contracting fee fixed over 20 years at EUR 172,560 per year. The saved energy costs of EUR 220,000 per year were greater than the contracting fee that created immediate financial benefit for Graz city's budget.

Figure 17: Illustration of the annual costs and benefits of the Green Light Graz 2010 project



Source: (Energie Graz GmbH & Co KG 2010; Grazer Energieagentur 2010).

Note: The estimate of costs and benefits of upgrade depends on such assumptions as on electricity prices (e.g. in 2010 prices were very low), interest time and light bulb lifetime. Due to this reason, the actual costs and benefits may be different from those initially estimated.

Project implementation and outcomes:

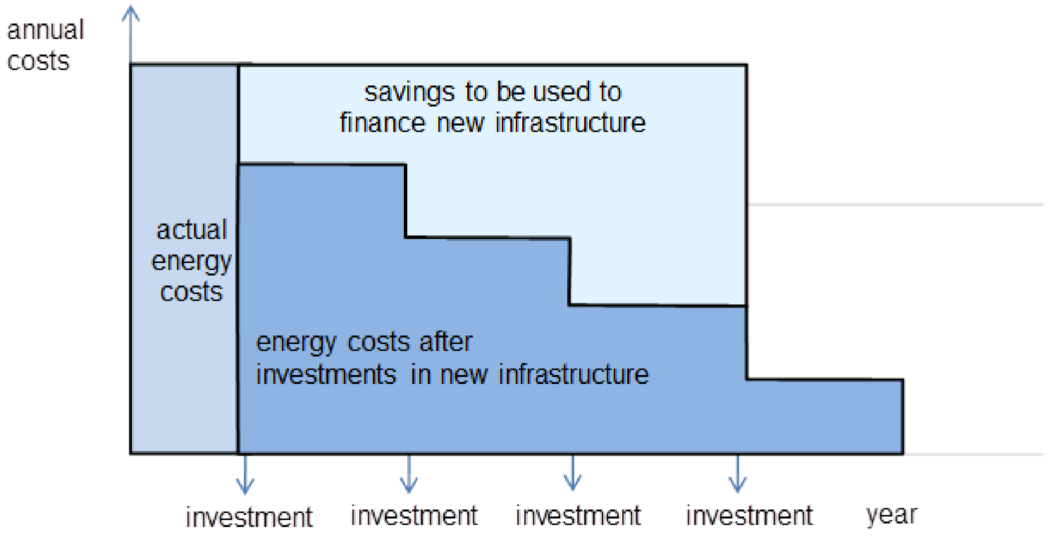
By 2010, all street lighting infrastructure was upgraded. The contracting period will end in 2027.

5.3.2. Model with staggered modernization

Model overview:

In this model (Figure 18), modernisation is stretched over a longer time period, avoiding the disadvantages of the previous model. There could be a modernisation time schedule, agreed upon between city and private partner, or a definition of maximum age of luminaires (and poles if these are included in the modernisation programme) at certain times during the term of the contract and at the end of the contract.

Figure 18: EPC – Model with staggered modernisation



Source: Authors' own figure.

Projects that can be financed with this model:

Models with staggered realization of the modernization (meaning carrying out the replacement of old luminaries with new energy efficient luminaries in a period stretched over several years or even decades) are suitable, if the existing luminaries are of different age and technology. It then makes sense to change the oldest and the least efficient luminaries first, and wait with other luminaries until they reach the end of the useful technical and economic life.

Advantages:

The advantage of this model is a more regular investment regime, so that the city always has a reasonably modern street lighting infrastructure, and that peaks in investment needs and building activity are avoided. The model also helps avoid the situation that all luminaires are replaced at the same time. In this model it is possible to focus on those luminaires with the worst energy efficiency first.

Disadvantages:

Major disadvantage is that energy savings, as well as the benefit of lower maintenance costs, will be achieved at a later stage than in the previous model.

Jurisdictions that have applied the model:

This is a model successfully realized in Germany.

Case study: the city of Hilden, Germany

Context:

In 2014, the city of Hilden tendered a contract with a term of twenty years. The contract included all operations, including energy supply, and the modernisation of more than 5,000 luminaires, which is the vast majority of all existing luminaires, as well as the modernisation of some 2,400 poles.

A key condition of this contract was a definition of a maximum average age, as well as a maximum age of any single luminaire and pole at fixed times (after 5, 10, 15 and 20 years). The costs of electricity were split between the private partner (direct costs) and the city (indirect costs such as taxes, dues and grid access costs). This means that both partners benefit from energy savings, and the task of bidders was to select the right luminaires to be modernised at the right time, while taking the age restrictions into account. Based on the total price over the 20-year-period and several organisational and technical concepts, offered by several bidders, the contract was awarded and started on 1 January 2015.

Project timeframe: 2015 – 2034.

Project scope:

Operations, including energy supply, and modernization of almost all luminaries and about half of the poles.

Key stakeholders:

- Customer: city of Hilden, Germany;
- Contractor for operation and modernization: SWARCO V.S.M. GmbH.

Financing structure:

Payments come from the city, but are compensated by part of the energy savings (indirect costs), while direct energy costs are covered by the private partner.

Project implementation and outcomes:

The project is still in its initial phase, but modernisation has already started, implementing an optimised time schedule stretching over the entire 20 year period.

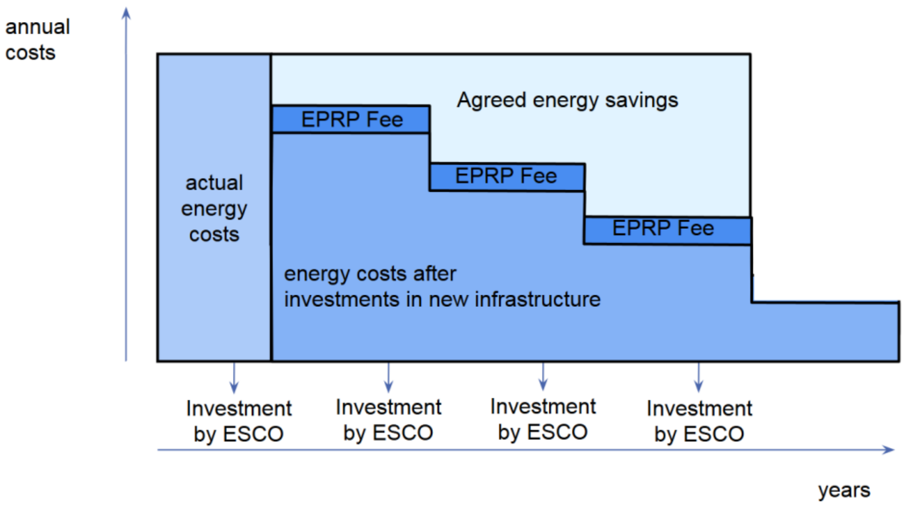
5.3.3. Model with related payments

Model overview:

When applying an Energy Performance Related Payment (EPRP) contractual arrangement, an ESCO guarantees energy savings for an agreed fee for undertaking work that will improve the energy efficiency of the street lighting infrastructure. The fee is contingent on energy savings, which means that if savings fall short, the ESCO loses a portion of its fee (SEAI, n.d.).

An EPRP combines energy performance guarantee with performance payment and a payment mechanism around a measurement and verification plan of the project, as illustrated in Figure 19. The EPRP model can be added as a clause to traditional contracts or tender documents, where it acts as a guarantee that the project actually fulfils the function for which it was intended but will also do it in a way that improves energy performance. The performance risk is shared between the municipality and the ESCO (SEAI, 2014). Typically, the contract ends after 12 months after the works are completed and the works are unlikely to be financed by the vendor.

Figure 19: Illustration of an EPRP model.



Source: Authors' own figure.

Jurisdictions that have applied the model:

As this model has emerged in Ireland, a few case studies to have applied this model are located in that country. The EPRP model which has also been applied to lighting infrastructure in the port of Cork and the Dublin Port Headquarters (SEAI 2014).

Advantages:

The energy efficiency related payments lead to a more accurate quantification and verification of energy savings. Therefore, the ESCO's and the municipality's objectives are aligned, as the ESCO looks beyond the final payment and focuses on the energy performance of the upgrade. Because of the related payments to energy savings, funding for such projects is more easily accessible (SEAI 2014).

Same as in other models involving private actors, an ESCO is likely to have more technical expertise than the municipality to guarantee the energy savings by implementing a street lighting upgrade. Another advantage is the nature of the contract, since the simplest form of an EPRP is similar to traditional contracting (SEAI n.d.) and can be combined with other financing models, such as grants or debt.

Disadvantages:

Similar to the model with staggered modernization, some potential to save energy costs in the early stages of the project is lost, because some of the modernization takes place at a later stage.

Projects that can be financed with this model:

Similar to the previous EPC models, projects with a high potential of energy savings are best suited for this model.

Case study: Carlow Kilkenny County, Ireland

Context:

Carlow Kilkenny County is located in the South-Eastern part of Ireland that amounts almost 100,000 inhabitants, of which close to 25,000 live in urban areas. Street lighting accounts for around 55% of the county's electricity consumption. In spite of variable and unsatisfactory light quality, the county had a challenge to upgrade street lighting because of high upfront costs. The project focuses on street lighting refurbishment to LED technologies while considering historical and touristic aesthetics factors.

Project timeframe: 2014- xx?.

Key stakeholders:

- which ESCO?
- Bank giving money to esco?
- Municipality of Carlow Kilkenny County;
- Sustainable Energy Authority of Ireland (SEAI).what what the role of SEAI? Should we keep it? Shall we add CKEA?

Project scope:

The project includes 9,800 lamps throughout the municipality. The first step of the project includes five streets and housing estates in the city equivalent to 59 lamps/lighting points.

Financial structure:

The total investment cost amounted to EUR 50,000 of which EUR 5,000 was financed by the EPC contract. Additionally, the municipality successfully applied for a 50% grant support from SEAI.

The municipality retains 10% of payments for the first year until the agreed energy savings are achieved. Maintenance costs are not included in the EPC contract, yet the increase in energy efficiency lowers the maintenance costs.

Project implementation and outcomes:

From the 59 refurbished lamps, the total electric capacity, the annual electricity consumption and the annual electricity costs were more than halved whereas the annual maintenance costs decreased by 82%.

6. Leasing and concession to a private partner

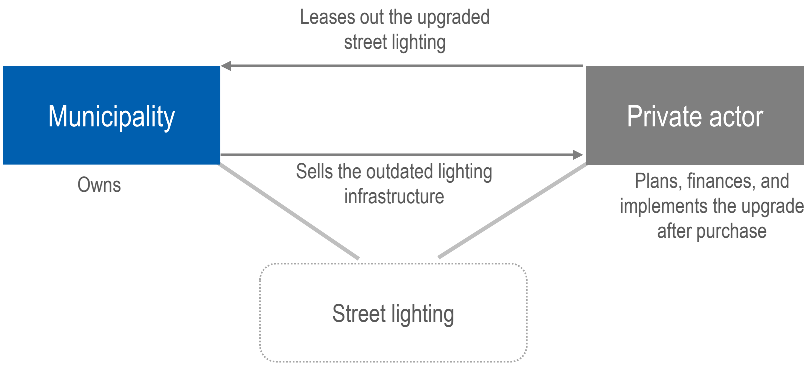
Recently, the world has seen a wide range of new forms of contractual arrangements between public and private actors to implement infrastructure projects. These actors enter into contractual arrangements to share responsibilities related to implementation and/or operation management of such projects. These models are refereed to public-private partnerships. There is a great variety of these models having different technical and financial features. Additionally to energy performance contracting that is also one of PPP forms, the present report features such PPPs as leasing and concession models as well as a private finance model, which are used in Europe to upgrade street lighting infrastructure.

6.1. Leasing street lighting by a contractor to municipality

Leasing gives the right to a lessee to use an asset even though it does not possess it. For street lighting, often sale-and-lease-back models are used finance overall street lighting upgrade, operation and management over a period of time for instance. According to this model, a municipality sells to a private contractor the street lighting infrastructure conditional to its upgrade, operation, and management. The municipality than leases it back from a private contractor for fixed fee over a period of time. Often in the end of the leasing contract, ownership rights are transferred back to the municipality.

Leasing is suitable for projects where the upfront investment cost is too high for self-financing by the municipality. With leasing the asset owner bears the investment cost, while the municipality benefits from using the upgraded infrastructure without increasing its indebtedness. The financial risk and cost are spread over time. However, in the long term, leasing will be more costly as compared to self-financing. In leasing the risks related to the assets performance and maintenance are shared between the partners, but at the same time municipalities will have less control over the assets. Depending on the contract provisions, leasing may also allow the municipality to repay the lease with the energy cost savings resulting from the upgrades (The Climate Group 2013).

Figure 20: A leasing-based model between a private partner and a municipality



Source: Authors' own figure.

We located the leasing model in Italy in the municipality of Cesena (please see the case study below) and in the municipality of Martignacco, but it is not very common in Europe. The model is often used by the jurisdictions in the United Stated, for example, by Pennsylvania and Texas (The Climate Group 2013). The city of Guadalajara, Mexico, has recently upgraded its street lighting using leasing model combined with governmental support (Makumbe et al. 2016a).

Case study – Cesena, Italy

Context:

The Municipality of Cesena is situated in Northern Italy within the Emilia-Romagna region and it is the capital of the Forlì-Cesena district along with Forlì. Cesena has a population of about 97,000 (2015).

The municipal department responsible for the public lighting services is the Public Construction Department. Its mandate is monitoring the service quality in terms of energy savings, optimization of the network, in compliance with current regulations. Furthermore, the municipality has the responsibility to direct the investment policies for new public illumination plants and infrastructures and to set new standards of quality, innovation and service organization.

As of January 2015, the municipality of Cesena was covered by a total of 21,000 lighting points that composed the public street lighting infrastructure. The total installed capacity is about 2,780 MW and the annual electricity consumption is about 11 GWh. The municipality's objective is to decrease the energy consumption by 30-40% and increase the effectiveness of lighting in public spaces. To contribute to the achievement of this objective, all existing and new street lighting installations are to be of LED technology (Burioli 2017).

Project timeframe: 2015 – 2027.

Project scope:

Out of the 21,000 lighting points, the municipality of Cesena has entrusted the ownership and management of most of the light points and traffic lights to Hera Luce Ltd under an agreement signed in 2010 and renewed in 2015. Following the agreement, 15,830 light points were transferred to the ownership to Hera Luce Lts, while the municipality remains to own 5,236 light points.

Key stakeholders:

- The municipality of Cesena – the implementing agency;
- Hera Luce Ltd - a private contractor which specializes in management of public lighting installations.

Financing structure:

The first project was implemented by Hera Luce Ltd where nearly 2.3 million euros to replace the most outdated lights with LED luminaries. The project covered 4,880 light points across various areas of the municipality and was completed by April 2017 covering 4,880 light points (Emilia-Romagna Region 2017; Gallesi 2017). Within the second agreement made in 2015 (15,830 lighting points), Hera Luce Ltd is also responsible for the following activities in relation to the light points that it owns until 2027:

- ordinary and extraordinary maintenance of the street lighting networks and public electrical installations;
- constant control over the estate of the network and the management of the emergency services in case of need and malfunction;
- technological improvements and energy saving solutions.

Hera Luce Ltd also is responsible for the preparation of the Investment Plan for modernizing the lighting network together with the municipality. The company is currently carrying out a full upgrade of all the light points it owns according to the investment plan.

The Municipality of Cesena is leasing the light points owned by Hera Luce Ltd over this period of time for a fee. After 2027, the ownership of the light points will be returned to the Municipality of Cesena. As for the remaining 5,236 light points that are the municipality's property, investments are made directly by the city, but they require smaller investment.

Project implementation and outcomes:

This model allows the Municipality of Cesena to engage private investor, Hera Luce Ltd, to finance the efficiency upgrades of the public lighting network as established within the agreement and in particular, according to the Investment Plan prepared together by Hera and the municipality.

Case study: Guadalajara, Mexico

Context:

Guadalajara is a 1.5 million city, fourth largest in Mexico. The city had the street lighting infrastructure not renovated for more than 30 years. The share of street lighting was around 18% of the city's total electricity use and the energy bill from street lighting was a significant burden on the budget. Still, many areas were unlit which contributed to the lack of safety in the city (Makumbe et al. 2016b).

Street lighting upgrades in Guadalajara were implemented under the National Public Lighting Program, which supports economically viable and energy saving LED public lighting projects. The program provides significant amount of technical guidance in project development for municipalities. It also offers financial assistance from the National Bank of Public Works and Services (Banobras) under request and if verified energy savings achieved are as envisaged by the project the program reimburses 15% of the total project cost (up to MXN 10 million (EUR 484 thousand)).

Project timing: 2013 - 2016

Project scope:

Half of the city's points of light (40,000 sodium-vapor luminaires) were replaced with LED luminaires. Those sodium-vapor luminaries which were removed but still functioning were used to replace the out-of-service luminaries in the areas not coved by the LED upgrades. The contracted installer Electrotec is responsible for the installation of the LED luminaries and their replacement during the warranty period, while the municipality is responsible for their maintenance (Makumbe et al. 2016b).

Key stakeholders:

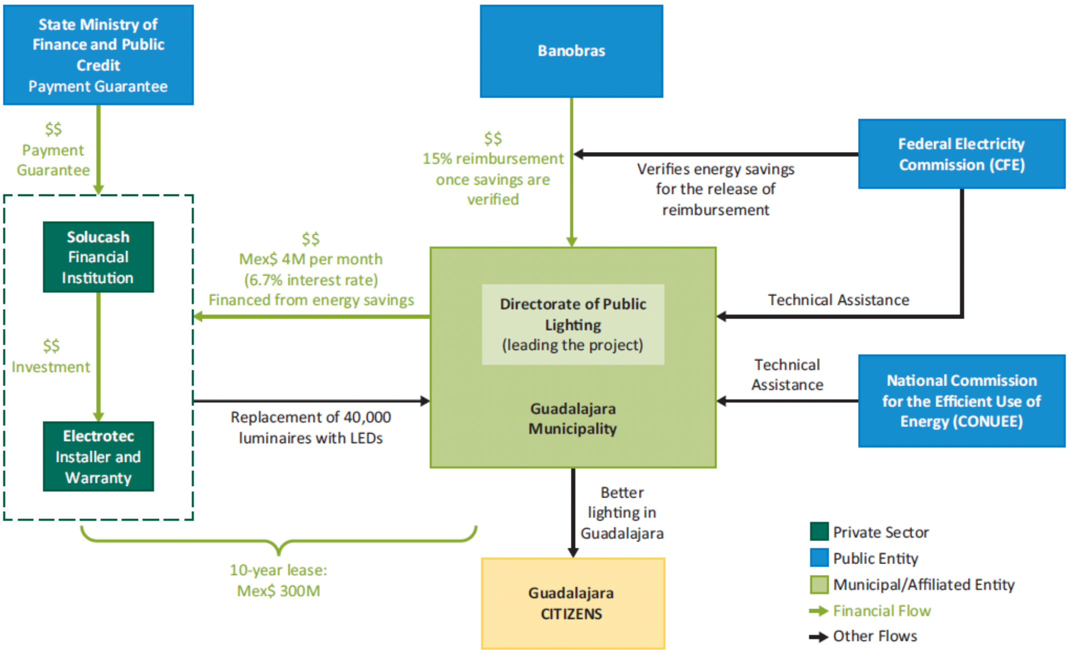
- Municipality of Guadalajara, Directorate of Public Lighting – project implementing agency.
- National Commission for the Efficient Use of Energy (CONUEE) – provided technical assistance to the municipality on the national technical standards and project implementation, certified technical viability of the project, and verifies the energy savings achieved by the project.
- The Federal Electricity Commission (CFE) – measures and verifies achieved energy savings.
- The National Bank of Public Works and Services (Banobras) – reviewed financial viability of the project.
- Electricidad y Tecnología SA de CV (Electrotec) – private contractor, conducts all upgrade related works.
- Solucash SA de CV SOFOM ENR (Solucash) – finance provider.

Figure 21 presents the main stakeholders of the model and their responsibilities.

Financing structure

The project is financed through a 10-year leasing contract for MXN 300 million (EUR 14.5 million). The contract is between the municipality, and a partnership between the installer Electrotec and finance provider Solucash. The municipality will finance the project from the energy savings and will pay the average monthly fee of MXN 4 million (EUR 190,000) to Solucash during the contract term. The municipality will gain the full ownership over the LED luminaries at the end of the leasing contract.

Figure 21: Financial structure of Guadalajara street lighting project



Source: (Makumbe et al. 2016b).

Expected monthly energy cost savings from the upgrades are expected to be around EUR 463,000. For cases when the municipality will not be able to cover its monthly payments for leasing from energy savings, there is also a payment guarantee provided by the federal government. In addition, if verified achieved energy savings correspond to the initial project targets, the municipality will receive a reimbursement of 15% of the total project cost (Makumbe et al. 2016b).

Project outcomes

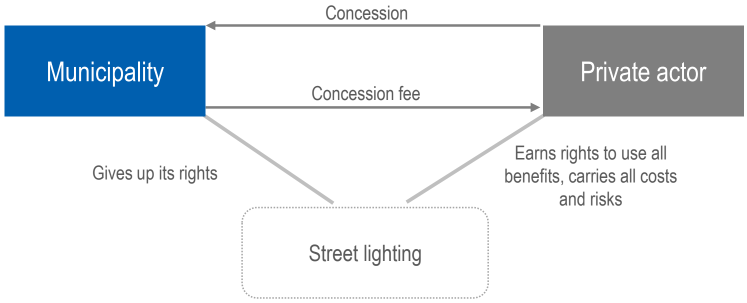
Expected energy savings from the project are between 50 to 55% from the baseline.

6.2. Concession to a private partner

Model overview

A municipality grants a concession to a private partner to operate and maintain street lighting infrastructure over a contract period. The municipality pays the private operator a concession fee for this service. The private partner can use its own funds or raise debt on the capital market and invest them into energy saving measures. The measures will reduce operation and maintenance costs that would allow the contractor to accrue resulting benefits. Tendering concession contracts are regulated by national legislation in each EU member state that had to be introduced in response to the a Directive 2014/23/EU on the award of concession contracts adopted on 26 February 2014. Figure 22 presents a simplified concession-model between a municipality and a private partner.

Figure 22: A concession-based model between a private partner and a municipality



Source: Authors' own figure.

Projects that can be financed with this model:

Any municipality can offer its lighting infrastructure to the private sector for a fee. Here, the limitations lie within the private sector, whether there are viable partners.

Advantages

The concession model is one of the very few financing models that provide the municipality with a steady cash inflow, as agreed upon in the concession contract. Furthermore, the municipality outsources all responsibilities of the lighting infrastructure to a private company, thus involving investment and expertise from the private sector into public infrastructure. This might boost technological innovation and efficiency in the project development and implementation phase (ESCAP 2008).

Disadvantages:

The concession model can be complex to setup and administer especially the negotiating and possibly tender phase may require manpower and time. Therefore the transaction costs could be high. Besides, once the contract is signed, close regulatory oversight is still required (ESCAP 2008).

Jurisdictions that have applied the model:

In EU, we located the concession model in the municipality of Azzano Decimo in Italy (Mazzolini M. pers. com.) and in the city of Paris (presented below). The number of municipalities in Brazil using the model was identified in xx.

Case study – The city of Paris, France

Context:

Public lighting is the second largest energy use of Paris. Street lighting in the city comprises of traffic lights, lighting of public spaces (e.g. squares or roads) and illuminations (e.g. lighting of building or sightseeing monuments). Altogether the city has 175,000 public lighting points, 30,000 lighting consoles, 21,000 traffic lights and 63,000 traditional street lights (candelabra) (Paris 2015). Paris has many years of experience with such PPP type with the French private utility EDF. Yet in 2011, the tender went to a new private partner, as presented in this case study.

Project timeframe: 2011- 2021.

Project scope: All street lighting within the municipality of Paris.

Key stakeholders:

- City of Paris;

- Concessioner: a consortium of companies "EVESA", consisting of ETDE, Vinci, Satelec, and Aximim.

Financing structure:

The city of Paris tendered the offer of almost EUR 450 million (excluding VAT) in concession fees to the private sector and chose the best fit from out of the several applications. For the period of the contract, the city transferred to EVESA the right to operate and maintain public street lighting and traffic lighting including the assistance to project management, asset management (vandalism, replacement of identical facilities, renovation of substations, network), and technical support for large development projects. Furthermore, according to the agreement, EVESA has to guarantee energy savings of 42 GWh over 10 years.

For these services, the municipality pays EVESA concession fees. The latter are financed from the city local budget, for instance from its budget lines for lighting infrastructure maintenance, including operations and maintenance; project management or fixed budgets for renovation and public asset management.

Project outcomes:

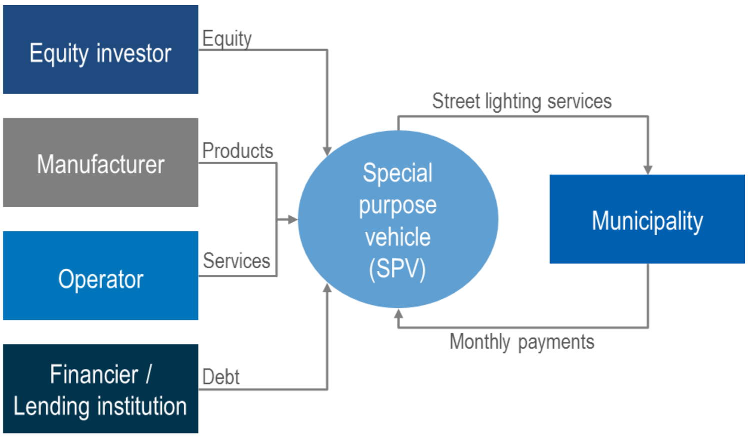
Earlier, the city of Paris committed to reach the target to reduce its GHG emissions by 75% between 2004 and 2050. Until 2020, the concessioner aims to further reduce energy consumption for street lighting by 30 % by refurbishing 85% of all lights within the contract period. The project has already reduced emissions by 24% since 2011 (EVESA 2014).

7. Project finance

Model overview:

Project finance is another model for municipalities to leverage limited public funds and raise private capital. In this model a special purpose vehicle (SPV) is established, which carries the investment project on its balance sheet (Figure 23). It is financed with the equity from private investors, debt from the lending institutions, and contributions from the municipality (De Marco et al. 2016). Project finance has a proven track record in large transportation and energy infrastructure projects (Esty and Sesia 2010). There is a growing interest and cases of applying this model for urban-scale energy efficiency projects, but no standardized approach has been developed yet (Limaye and Limaye 2010).

Figure 23: Example structure of SPV model



Source: Authors' own figure.

In a SPV model, there are one or several private sector partners, e.g. equity investors, manufacturers, debt providers and asset operators. The SPV is responsible for design, installation, operation and management of the street lighting infrastructure at its own cost for a specified contract period. The private sector partners bear the majority of risks associated with the assets ownership over the contract life (De Marco et al. 2016).

The contracts are typically for 20-25 years. The contract price is based on the required investment, cost of capital, and operation and maintenance cost. The municipality pays monthly unitary charges to private sector partners, based on the contract price. These payments represent the key security for funders (Scottish Futures Trust 2013; WBG 2016).

Projects that can be financed with this model

The project finance model is suitable for large projects with capital costs over ~EUR 20 million. The projects have to be able to attract private investors and therefore, be financially sustainable. Financial sustainability depends on the revenues and profit to be generated during the contract term and is also linked to the municipality's credit profile. Supporting public instruments such as grants, tax exemptions, tax-free bonds, or credits can significantly improve project viability and facilitate private sector involvement. This model also implies long term contracting of private actors for operation and maintenance of street lighting assets (Scottish Futures Trust 2013). The simple regulatory structure, clear legislative provisions, as well as fast and transparent bidding process are prerequisites for successful project implementation (Mendoza et al. 1999; Spillers 2000; De Marco et al. 2016).

Advantages:

The key advantage of this model for the municipalities is an opportunity to leverage private capital and carry out project implementation off the municipality's balance sheet. The off-balance structure is an important advantage for investors, manufacturers or operators as well. Another advantage from the perspective of both public and private sectors is isolating the project risks within the SPV, which enhances the attractiveness of the investment. Long time frames of the contract will provide stability of the operations and maintenance of the assets (De Marco et al. 2016; Link 2012). Additional benefit for the municipalities is that if private sector partners fail to deliver the services agreed in the contract, there are foreseen deductions or withholding of payments or even penalties by the municipality.

Disadvantages

The main challenge of using the project finance model is high transaction costs related to the preparation and implementation of the SPV. This model is not suitable for small projects. Creating a consortium of several municipalities can be one option to create a scale sufficient for SPV and diversify investment portfolio and risks. However, it will bring in additional costs related to the governance and structure of the consortium. Project finance might also imply long time frames from project start to actual development (De Marco et al. 2016; Bonetti, Caselli, and Gatti 2010; Makumbe et al. 2016).

Jurisdictions that have applied the model

Project finance has been widely used for street lighting investments across the United Kingdom (UK) under the Private Finance Initiative (PFI) and Private Finance 2. As of March 2016, 32 UK jurisdictions applied SPV models for street lighting infrastructure investments of an average capital value of £45 million (EUR 57 million)[9] (HM Treasury 2016).

Project finance is also a common model applied in Italy. It is used for instance by the municipalities of Udine, Codroipo, Spilimbergo, Mereto di Tomba, Morsano al Tagliamento, and others (Mazzolini pers. com.).

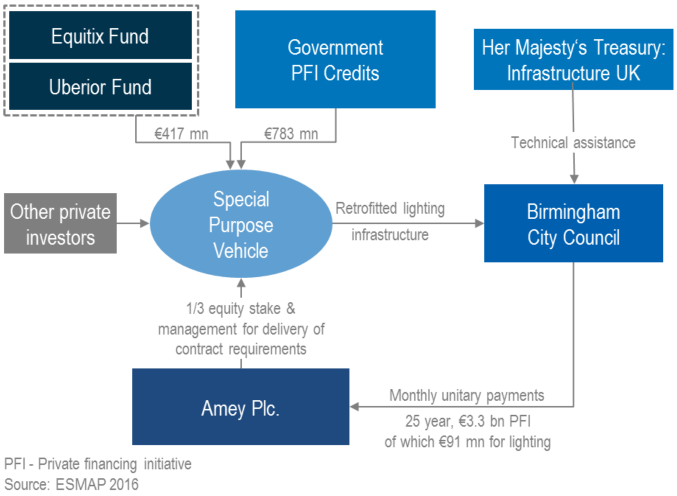
Case study – City of Birmingham, UK

Context:

The Birmingham LED street lighting project is part of a larger public private partnership on modernization of the city's streets, roads, tunnels and other assets – the Birmingham Highway Maintenance and Management Private Financing Initiative (HMMPFI) implemented in 2007-2035. The project was implemented under the Private Financing Initiative (PFI), which is a national government support in the form of credits or grants to facilitate private sector investment. Birmingham's Sustainable Community Strategy 2026, endorsed in 2008, was an additional driving force to implement the LED program for efficient street lighting. The total value of the HMMPFI is £2.6 billion (EUR 3,3 billion) of which approximately EUR 91 million is assigned for lighting (Makumbe et al. 2016a).

[9] Here and further, the currencies are converted to EUR according to currency conversion according to the exchange rate as of 31 March 2016 published by the European Central Bank: GBP 1 = EUR 1.2633 (https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates/html/eurofxref-graph-gbp.en.html)

Figure 24: Simplified structure of Birmingham LED street lighting project



Source: (Makumbe et al. 2016a).

Project timeframe: 2007–2035.

Project scope:

The Birmingham LED program for efficient street lighting included upgrade, maintenance and management of 97,000 streetlights. It was a Europe's first LED street light project financed through project finance. The program is expected to achieve energy cost savings of 50% or up to £2 million (EUR 2.5 million) annually (Makumbe et al. 2016a).

Key stakeholders:

- Implementing agency: Birmingham City Council
- Equity and service provider: Amey Plc.
- Private investors: Equitix Fund, Uberior Fund and other financiers
- Technical assistance: Her Majesty's Treasury, Infrastructure Fund
- PFI credits: UK Government

Financing structure:

Amey plc was contracted by Birmingham City Council as the main service provider for 25 years. Infrastructure UK[10] provided technical assistance to structure the PFI deal. A special purpose vehicle was created for project implementation with oversight by Birmingham City Council and Amey Plc. The total project value is £2.6 billion (EUR 3.3 billion), the lighting part is around EUR 91 million. This includes £620 million (EUR 783 million) of PFI credits from the UK government in the form of a grant, £330 million (EUR 417 million) from the Lloyds (Uberior Fund) and the Equitix Investment Fund, as well as other investors and debt providers (Makumbe et al. 2016a).

[10] Infrastructure UK (IUK) was a body within Her Majesty's Treasury which focused on long term infrastructure priorities and facilitation of private sector. One of its activities included supporting and providing guidance implementation of PFIs. In November 2015, Infrastructure UK (IUK) was announced to be merged with the Major Projects Authority (MPA) in 2016, creating the Infrastructure and Projects Authority.

Over the contract life time Birmingham City Council pays to Amey Plc. monthly unitary payments for the initial investment and maintenance and operation cost. For the first 5 years of the contract, an independent certifier approves increases of monthly unitary charges by approximately 4%. The contract foresees cases for deductions in payments by the city (Makumbe et al. 2016a).

Project implementation and outcomes:

The LED program for efficient street lighting is implemented in two stages. The core investment (replacement of 57,404 luminaires) is made in the first five years and the rest of the luminaries are updated in the following twenty years. All assets are operated and maintained over the contract period of twenty five years. Through the SPV, Amey Plc. is responsible for selection, purchase, installation and maintenance of LED luminaires. It takes the full asset technology and performance risks. Birmingham City Council can audit the performance of Amey Plc.

The final outcomes of the investment are still to be seen but the project is already considered to be a positive case of modernizing urban infrastructure with private capital and sparing the municipality from raising the upfront capital itself. Key drivers of the project success are availability of national framework or support such as the PFI credits, availability of technical assistance to make sure the contract is well structured and clear municipality policy priorities.

8. Financing by utilities

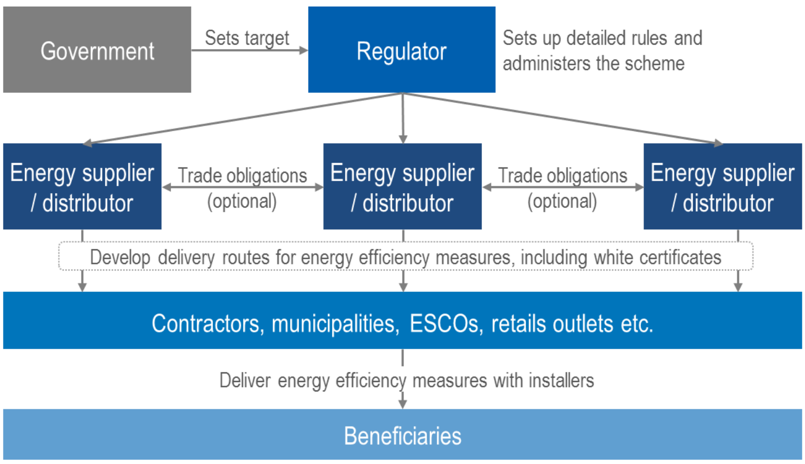
8.1. Energy efficiency obligation schemes

Energy Efficiency Obligation Schemes (EEOSs) are operational in 11 EU member states – Denmark, UK, Ireland, France, Spain, Italy, Latvia, Poland, Bulgaria, Austria, and Slovenia. EEOSs are one of the policy measures suggested for implementation by the Article 7 of the Energy Efficiency Directive (EED) in order to deliver the energy savings amongst final energy consumers. In Europe, EEOSs have proved to deliver substantial improvements in energy efficiency and are responsible for a large fraction of energy efficiency improvements achieved (European Commission 2016c).

EEOS is a policy mechanism enforced by law that requires entities covered by the scheme to meet certain energy saving targets through investments into eligible end-use energy efficiency measures. Three key features of EEOS are 1) a set energy savings target, 2) defined liable entities that must meet this target and 3) a system that administers, regulates and verifies the activities within the EEOS (RAP 2012).

Entities covered by the EEOS are typically energy providers and / or distributors. In order to meet their energy savings targets, liable entities can either deliver eligible energy saving measures themselves, or outsource contractors and service providers to implement energy efficiency measures on their behalf, or purchase verified energy savings achieved by other accredited parties, or, finally, contribute to a fund that finances eligible energy efficiency projects. These options will vary depending on the specific EEOS design. If liable entities fail to deliver the required energy savings they will face financial penalties (RAP 2012). Figure 25 presents the architecture and main actors of utility obligation schemes.

Figure 25: Utility obligation scheme



Source: (Rosenow 2017).

EEOSs also vary in terms of eligible energy efficiency measures that can be taken by the liable entities. Many EEOSs have a list of preapproved energy efficiency measures with assigned energy saving value assigned for each measure that can be claimed by the liable entities for meeting their obligations. EEOSs may also provide a procedure for approving additional energy efficiency measures that are not on the list and methodology for calculating the energy savings values for more complex projects. To cover the investment cost of meeting the energy saving obligations, covered entities can pass-through these cost to the end-users or use support from the government if it is available under the EEOS (RAP 2012).

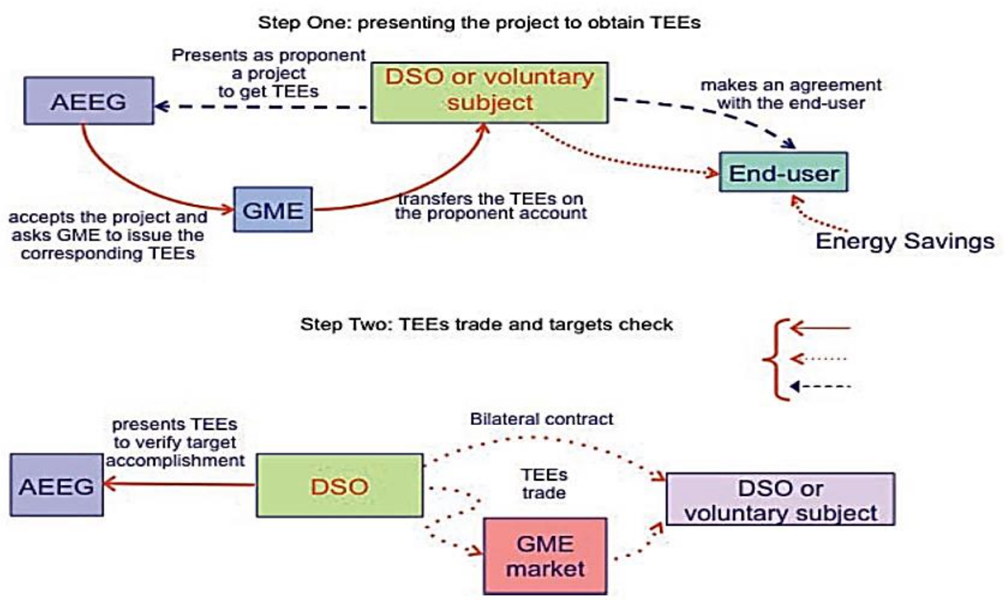
In EEOSs trading of energy savings certificates among obligated parties and other accredited entities is allowed. An energy efficiency certificate (or white certificate) is an authorised legal instrument guaranteeing that a certain amount of energy savings has been achieved. Trading provides additional option for liable entities to either buy additional energy savings to meet their obligations or sell the energy savings certificates they do not need. Trading can take place on a dedicated trading platform or carried out bilaterally (RAP 2012). Among the EU member states, only Italy EEOS has tradable white certificates in place (European Commission 2016c).

Case study: White certificate scheme, Italy

The Italian white certificate scheme started in 2004. The purpose of the scheme is to meet the requirements of the EED transposed to the national legislation, to promote energy efficiency and to strengthen ESCO market. The scheme sets an annual national primary energy saving targets and imposes obligations on electricity and gas distributors with more than 50,000 customers to meet these targets through implementation of energy efficiency measures.

The annual primary energy saving targets are set by the Ministries of Economy and Environment. Gestore Servici Energetici (GSE) is responsible for the administration of the scheme and monitoring and verification of energy savings, with technical support from the Italian Energy Agency (ENEA) and other public bodies. Penalties are set by the AEEGSI (Regulator of the energy markets). The scheme covers 61 entities – 13 electrical distributors and 48 natural gas distributors. Obligated entities can either implement energy efficiency measures themselves, or outsource the implementation to third parties through bilateral contracts, or purchase the verified energy savings via trading platform (ATEE 2015). Figure 26 presents the main stakeholders on the Italian white certificate scheme and their relations.

Figure 26: Italian white certificate scheme



Source: (Di Santo et al. 2011).

For each verified saved tonne of energy (tonne of oil equivalent) generated by implementing energy efficiency measures, entities receive a white certificate. It is a tradable instrument that certifies that a specific reduction of energy consumption has been achieved. Not only obligated electricity and gas distributors can pursue energy efficiency measures and generate white certificates. Third parties, such as no-obligated distributors, ESCOs, companies or organisations having an energy manager or ISO-certified energy management system in place, can do so too. Having achieved and verified a certain amount of energy savings, they can sell their white certificates to the obligated parties that need the certificates to meet their obligations under the scheme (GSE 2015).

Eligible energy efficiency measures cover basically all end-use sectors, except for efficiency improvements in electricity generation. Each of the eligible implemented measures gets a white certificate for five years (for building envelope related measures – eight years) (Di Santo et al. 2014). Analytical projects and monitoring plan projects are also eligible for white certificates (ATEE 2015). The cost of implementing the measures born by the obligated entities is passed through on the electricity and gas customers' bills (GSE 2015).

Most (96%) of the white certificates are generated by the non-obligated parties and then traded. The trade takes place through either bilateral contracts or the trading platform (ATEE 2015). As of 2015, 48 million of white certificates were traded, mainly (65%) by bilateral agreements (GSE 2015). The scheme boosted the ESCO market in Italy. ESCOs represent 78% of entities engaged in the scheme (GSE 2015). The major share (72%) of total white certificates was issued to the ESCOs (ATEE 2015), while obligated distributors generate less than 5% of white certificates (GSE 2015).

In 2015, most of the white certificates (64%) were issued for energy efficiency measures in the industrial sector. This is due to the link of white certificates scheme with the energy manager obligation where the industry sector is the main target group. Only 4% of energy efficiency improvements were in lighting, and the remaining 32% were measures in the civil sector (GSE 2015).

8.2. On-bill financing

On-bill financing is a form of utility financing, where a utility provides a loan to a municipality for the upfront investment and the municipality repays the cost through its energy bills. Since the utility provides initial finance it can require and oversee using specific technology for the upgrades. On-bill financing has relatively low risks to both utility and municipality as long as the municipally pays its energy bills. The implementation arrangements are also relatively simple (Smart Cities Council 2015).

On-bill financing is not common in Europe, but more spread in the United States. There, on-bill financing programmes are mostly targeting energy efficiency improvements by homeowners and businesses, but municipalities also have a possibility to use them for street lighting upgrades. The utilities in California, Pacific Gas and Electric (PG&E) and Southern California Edison (SCE), are the most active in on-bill financing (U.S. Department of Energy 2016). Similar programmes are also operated by other utilities, for example, San Diego Gas & Electric.

Pacific Gas and Electric (PG&E), which operates in Northern California, provides on-bill financing for street lighting projects. PG&E provides zero-interest loans of USD 5,000 – 250,000 to public institutions for up to 10 years for energy efficiency technology upgrades, including LED street lighting projects. Loan repayment is based on the projected energy savings and will be included in the monthly utility bill. To qualify for the on-bill financing program the estimated energy savings must be sufficient to repay the loan during the repayment term (Pacific Gas and Electric Company 2017). As of 2016, several hundred projects that upgraded around 180,000 municipally-owned lights were financed through the PG&E on-bill financing program (U.S. Department of Energy 2016).

Southern California Edison (SCE) operates in Southern and Central California it has similar on-bill financing conditions to the municipalities for energy efficiency improvements, including LED retrofits of municipal-owned street lights. The loans are for USD 5,000 - 250,000 for up to 10 years. The monthly repayment amount is equal to the estimated monthly reduction in the utility bill resulting from the project (Southern California Edison 2017).

9. Financing by citizens: crowdfunding

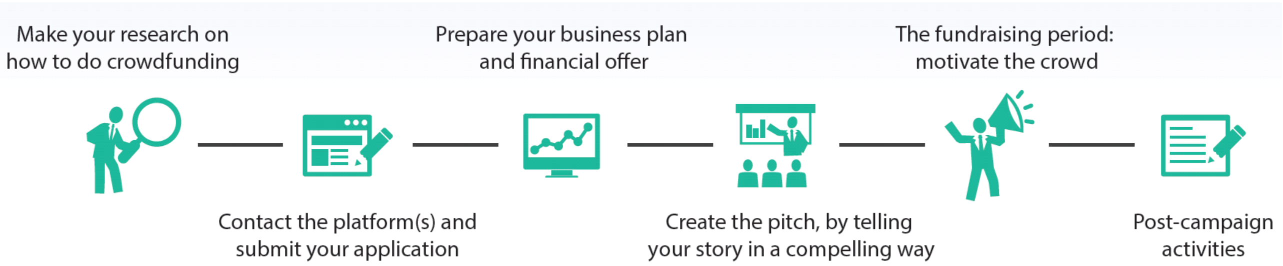
Crowdfunding is raising funding for projects from a large number of people or investors through online platforms. Crowdfunding platforms are websites where fundraisers and investors meet – fundraisers open a call to collect funds for a project and interested investors pledge their resources. Crowdfunding is relatively new financing technology and most often used by young innovative companies and start-ups. As the financing volumes through crowdfunding grew steeply in the last four years, many community or city projects are also increasingly using this instrument (European Commission 2016b).

There are several models of crowdfunding which define terms between the fundraiser and the people who provide finance (crowd-investors):

- Investment-based crowdfunding – fundraising company issues equity or debt through a crowdfunding platform;
- Lending-based crowdfunding or peer-to-peer – obtaining funds from crowd-investors through online platform in a form of loan agreement;
- Invoice trading crowdfunding – raising finance by selling unpaid invoices or receivables to a pool of investors through online auction;
- Reward-based crowdfunding – raising funding from individuals or businesses and in return providing a certain reward in a form of goods or services;
- Donation-based crowdfunding – receiving donations from individuals for a specific project without a financial or other material returns;
- Hybrid models – combining different approaches mentioned above (European Commission 2016b).

Figure 27 illustrates the main steps of raising finance through crowdfunding platforms.

Figure 27: Main steps of how to approach crowdfunding



Source: (European Commission 2016a).

While financial returns do play important role, often the main reason why people contribute to a specific project is their interest in this project. Crowdfunding creates a community around the project, where people can be more involved and provide useful insights and ideas to the project. Raising a share of finance need through crowdfunding can help to attract additional investors.

As with any business model, crowdfunding has risks. The main risks of crowdfunding are lack of guarantee that the sufficient amount of funding is raised, problems with the crowdfunding platform, investors' inexperience or wish to exit, lack of regulation, and issues with responsibilities towards multitude of small investors. From the investor point of view the risks include losing part of the capital or not getting the expected returns, lack of a secondary market, insolvency of the platform operators, misinformation or insufficient information to price the securities invested correctly (European Commission 2016b).

Crowdfunding has been growing fast in the last four years, especially in the United Kingdom, France and Germany. In 2015, EUR 4.2 billion was raised through crowdfunding in the EU (European Commission 2016b). The majority of projects used models with financial returns, for example lending-based, investment-based or invoice trading crowdfunding (ibid.). Some of the main development trends of crowdfunding are consolidation and internationalisation of crowdfunding platforms, and a growing number of institutional investors, namely venture capital and angel investors, co-investing alongside individuals (ibid.).

Case study – Bettervest crowdfunding platform

Bettervest is a Germany-based crowdfunding platform for climate change mitigation projects. As of 2017, it helped raise funding for ca. 50 energy efficiency projects in Germany and other countries, which range in terms of technology and funding size. The project size ranges between EUR 4,000 and EUR 600,000 with a growing tendency. Bettervest (Bettervest 2017a) reports that all their projects reached its funding target. Current and accomplished projects can be found on the platform website Bettervest[11].

Among Bettervest projects, there have been also those focusing on lighting upgrades. For instance, one of them supported lighting upgrades of a public school in Szeged, Hungary. The school enrols 1,150 students and it had a significant potential for energy savings if conventional lighting technologies would be replaced with LEDs. Through Bettervest, the school raised EUR 46,400 from 92 investors.

Having the funding, the school signed a 10 year lease-purchase contract with LED-LIGHT-Germany, according to which it pays LED-LIGHT-Germany EUR 6,542 per year for upgrades and installation works. The contract also transfers the obligation towards the crowd-investors from the school to LED-LIGHT-Germany. Over 7 years LED-LIGHT-Germany will have to pay back 100% of the funds borrowed from the crowd-investors; additionally it has to pay them 7% returns on investment. The project is expected to deliver more than 70% of energy savings and significantly reduce the school's energy and maintenance costs (Bettervest 2017b).

[11] https://www.bettervest.com.

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Annex I. Methodology

There have been several data collection approaches, which we relied on. Above all, we gathered information available in the public domain. In particular, we identified and learned the documentation of projects, which have already conducted similar studies in the past. We also gathered other information available, e.g. from reports, articles, interviews, and internet websites. Finally, we used the extensive experience of SWARCO as manager of street lighting infrastructures in a large number of cities under a variety of different regimes and models. From our review, we concluded that so far there has been no recent comprehensive catalogue of the business models and best practices for energy efficient street lighting in Europe. Therefore, we identified individual case studies from additional surveys and personal interviews.

We surveyed the project target group using two questionnaires. First, we conducted a detailed survey among project partners using an online-based questionnaire. After the analysis of this internal survey, we further improved the questionnaire, and sent it out to the expert community and stakeholders related to street lighting beyond our consortium. For this, we identified the contacts of 34 associations of municipalities, cities, towns and countries in Central Europe and asked them to forward our survey to their members. We also identified the contacts of around 200 key stakeholders from the priority group of our task and sent them invitations to fill out the survey. These included representatives from regional or national energy agencies, utilities, product manufactures, engineering service providers, energy services companies, and researchers. Finally, we sent out the survey though the mailing list Climate-L.[12]

Our survey was answered by 59 respondents. Of these, 55 respondents were from the EU countries. These were the representatives of 15 municipalities, two associations of municipalities including the Association of Cities of the Republic of Croatia; the Association of Polish Cities, four regional energy and development agencies including the North-West Croatia Regional Energy Agency, the Energy Agency for Southeast Sweden, the APE FVG Energy Management Agency of Friuli Venezia Giulia, and AGIRE Energy Agency of the Province of Mantova of Italy; five lighting product manufactures; three energy service contractors and/or energy service companies and/or their associations; 21 research organisations or consultancies, and six consumers. For details, please see our Deliverable D.T2.3.1. Baseline inventory.[13]

Each business model was analysed in a common framework. First, we provided a model overview drawing its schematic structure e.g. its key actors and their roles. Second, we analysed the types of projects, which could be financed using these models. Third, we argued about the advantages and disadvantages of the models. Finally, for each business model we provided a selected case study, for which we went even into deeper details of the model context, scope, stakeholders, implementation experience, and outcomes.

Above all, we focused on the financing models and their case studies in Central Europe. However, when a useful model was identified but was available only outside Central Europe, we include such case studies prioritizing such from the EU, then from Europe, and finally worldwide.

To validate our results, we contacted organizations, who were involved into the implementation of case studies. These included municipalities, their companies, and financing intermediaries. These organizations and individuals are listed in the acknowledgment section.

[12] Please see http://sdg.iisd.org/sdg-update/about-the-sdg-update-newsletter/ for information on Climate-L.

[13] Novikova, A., Stamo, I., Stelmakh, K., and Hessling, M. 2017. Guideline on finding a suitable financing model for public lighting investment: Deliverable D.T2.3.1 Baseline inventory. Berlin: University of Greifswald, IKEM, SWARCO.